1992 ANNUAL REPORT

to the

GOVERNMENTS OF CANADA, UNITED STATES, SASKATCHEWAN AND MONTANA

by the

POPLAR RIVER BILATERAL MONITORING COMMITTEE

COVERING CALENDAR YEAR 1992

December 1993

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Poplar River Bilateral Monitoring Committee

Department of State
Washington, D.C., United States

Governor's Office
State of Montana
Helena, Montana, United States

Department of External Affairs
Ottawa, Ontario, Canada

Saskatchewan Environment and
Resource Management
Regina, Saskatchewan, Canada

Ladies and Gentlemen:

During 1992, the Poplar River Bilateral Monitoring Committee continued to fulfill the responsibilities assigned by the governments under the Poplar River Cooperative Monitoring Agreement dated September 23, 1980. Through the exchange of Diplomatic Notes, on March 12, 1987, the Arrangement was extended to March 1991. In July 1992, another exchange of Diplomatic Notes extended the Arrangement retroactively from March 31, 1991 to March 31, 1996. In addition, the Arrangement was modified to terminate quarterly exchange of data and substitute an annual exchange of data.

The enclosed report summarizes current conditions and compares them to guidelines for specific parameter values that were developed by the International Joint Commission under the 1977 Reference from Canada and the United States. After examination and evaluation of the monitoring information for 1992, the Committee finds that the measured conditions meet the recommended objectives. However, the Committee notes that flow-weighted concentration of total dissolved solids in streamflow in the East Poplar River at the International Boundary continues to increase and is approaching the long-term objective of 1,000 milligrams per liter.

During 1992, monitoring continued in accordance with Technical Monitoring Schedules outlined in the 1991 Annual Report of the Poplar River Bilateral Monitoring Committee.

Herein is the 12th Annual Report of the Poplar River Bilateral Monitoring Committee. This report discusses the Committee activities of 1992 and presents the proposed monitoring schedule for 1993.

Yours sincerely,

Joe A. Moreland
Chairman, United States Section

R.A. Halliday
Chairman, Canadian Section

Gary Fritz
Member, United States Section

D.D. Nargang
Member, Canadian Section

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The Poplar River Power Station completed its ninth full year of operation in 1992. The two 300-megawatt coal-fired units generated 4 692 000 gross megawatt-hours (MW/h) of electricity, 103 percent from 1991 and 102 percent from 1990. In 1992, the average capacity factor for Unit No. 1 was 92.8 percent and the average capacity factor for Unit No. 2 was 88.2 percent.

Monitoring information collected in both Canada and the United States during 1992 was exchanged in the spring of 1993. In general, the sampling locations, frequency of collection, and parameters met the requirements identified in the 1992 Technical Monitoring Schedules set forth in the 1991 annual report.

Regional drought conditions persisted during 1992 resulting in below normal streamflows. The March to October recorded flow of the Poplar River at the International Boundary for 1992 was 2 080 cubic decametres (dam^3) which was 21 percent of the 1931 to 1991 median seasonal flow. The 1992 recorded flow volume of the East Poplar River at the International Boundary was 1 860 dam^3. This volume is 54 percent of the median annual flow since completion of Morrison Dam in 1975. The on-demand release, in accordance with the apportionment recommendations of the International Joint Commission (IJC), entitled Montana to 370 dam^3 for 1991-92 to be delivered between May 1 and May 30, 1992. A volume of 480 dam^3 was delivered during this period.

1.0 INTRODUCTION

The Poplar River Bilateral Monitoring Committee was authorized for an initial period of five years by the Governments of Canada and the United States under the Poplar River Cooperative Monitoring Arrangement dated September 23, 1980. A copy of the Arrangement is attached to this report as Annex 1. On March 12, 1987, the Arrangement was extended by the Governments for four years to March 1991. In July 1992, the Arrangement was further extended retroactively from March 31, 1991 to March 31, 1996 following a request from the Committee in 1991. A more detailed account of the historical background of the Arrangement is contained in the 1990 Annual Report of the Poplar River Bilateral Monitoring Committee.

The Committee oversees monitoring programs designed to evaluate the potential transboundary impacts from SaskPower's (formerly Saskatchewan Power Corporation) coal-fired thermal generating station and ancillary operations near Coronach, Saskatchewan. Monitoring is conducted in Canada and the United States at or near the International Boundary for quantity and quality of surface and ground water and for air quality. Participants from both countries, including Federal, State and Provincial agencies, are involved in monitoring.

The Committee submits an annual report to Governments which summarizes the monitoring results, evaluates apparent trends, and compares data to objectives or standards recommended by the International Joint Commission to Governments, or to relevant Federal, State or Provincial standards. The Committee reports to Governments on a calendar year basis. This report is the twelfth in the series. The Committee is also responsible for drawing Government's attention to definitive changes in monitoring parameters which may require immediate attention.

A responsibility of the Committee is review of the adequacy of monitoring programs in both countries and recommending changes in Technical Monitoring Schedules to Governments. The Schedules are updated annually to document changes in monitoring locations, sampling frequencies, parameter lists, and analytical techniques. The Technical Monitoring Schedules listed in the annual

report (Annex 2) are given for the forthcoming year. The Committee reviews and proposes changes to the Technical Monitoring Schedules as information requirements change.

2.0 COMMITTEE ACTIVITIES

2.1 Membership

The Committee is composed of representatives of the Federal Governments of the United States and Canada, the State Government of Montana, and the Provincial Government of Saskatchewan. In addition to the representatives of Governments, two ex-officio members serve as local representatives for the State of Montana and the Province of Saskatchewan.

During 1992, members of the Committee included: Mr. J.R. Knapton, U.S. Geological Survey, United States representative and CoChairperson; Mr. R.A. Halliday, Environment Canada, Canadian representative and CoChairperson; Mr. A. Wittich, Governor's Office, Montana representative; Mr. D.D. Nargang, Saskatchewan Environment and Resource Management, Saskatchewan representative; Mr. C.W. Tande, Daniels County Commissioner, Montana local ex-officio representative; and Mr. J.R. Totton, Reeve, R.M. of Hart Butte, Saskatchewan local ex-officio representative.

2.2 Meetings

The Committee met on June 2 and 3, 1992, in Coronach, Saskatchewan. Delegated representatives of Governments except the representative from the State of Montana attended the meeting. Neither of the ex-officio members were in attendance. In addition to Committee members, several technical advisors representing Federal, State and Provincial agencies participated in the meeting. During the meeting, the Committee reviewed the operational status of the power plant and mine; examined data collected in 1991 including surface-water quality and quantity, ground-water quality and quantity, and air quality; established the Technical Monitoring Schedules for 1992; considered a draft report on

quality-assurance results; discussed proposed changes in water-quality objectives; and toured the power plant, ash lagoons, mine, and other ancillary facilities. The Committee also prepared the first draft of the 1991 Annual Report to Governments.

2.3 Review of Water-Quality Objectives

The International Joint Commission in its Report to Governments, titled "Water Quality in the Poplar River Basin," recommended that the Committee "periodically review the water-quality objectives within the overall Basin context and recommend new and revised objectives as appropriate." In 1991, the Committee undertook a review of water-quality objectives. A subcommittee composed of Mr. J.R. Knapton, U.S. Geological Survey; Mr. J.-G. Zakrevsky, Environment Canada; Mr. A. Horpestad, Montana Department of Health and Environmental Sciences; and Mr. D.D. Nargang, Saskatchewan Environment and Resource Management, was formed to review and recommend changes in water-quality objectives.

The subcommittee examined the entire data base collected during the last eleven years of monitoring. This data base has led to a better understanding of background conditions in the basin and documented the presence or absence of trends in monitored constituents.

The subcommittee agreed that dissolved trace elements should be dropped from the water-quality objectives. The group reached consensus that total trace element concentrations provided more meaningful information but that differences in laboratory analytical procedures and field techniques would have to be investigated to determine comparability of data.

The subcommittee noted that mercury concentrations in tissue from fish in Cookson Reservoir are less than Canadian consumption guidelines. However, the subcommittee recommended that fishery experts be consulted before a decision is made to drop the objective.

The subcommittee also reviewed the water-quality objectives for 5-year and 3-month flow-weighted concentrations for total dissolved solids and boron. Although the subcommittee agreed that calculation procedures to determine flow-weighted concentrations are time consuming and probably scientifically questionable, no consensus was reached on alternative objectives or procedures.

Recommendations of the subcommittee are summarized in Table 2.1.

Table 2.1 Recommended Water-Quality Objectives.

PARAMETER	PRESENT OBJECTIVE	RECOMMENDATION	NEW OBJECTIVE
Boron, total	[1]3.5/2.5	Discontinue flow weighting	?
TDS	[1]1500/1000	Discontinue flow weighting	?
Aluminum, dissolved	0.1	Discontinue	--
Ammonia, un-ionized	0.02	Base objective on temperature and pH (table to be done later)	--
Cadmium, total	0.0012	Continue as is	0.0012
Chromium, total	0.05	Discontinue	--
Copper, dissolved	0.005	Discontinue	--
Copper, total	1.0	Continue as is	1.0
Fluoride, dissolved	1.5	Continue as is	1.5
Lead, total	0.03	Continue as is	0.03
Mercury, dissolved	0.0002	Change to total	0.0002
Mercury, fish (mg/kg)	0.5	Discuss with fisheries people	?
Nitrate	10	Continue as is	10
Oxygen, dissolved	[2]4.0/5.0	Objective applies only during open water	[2]4.0/5.0
SAR (units)	10.0	Continue as is	10.0
Sulfate, dissolved	800	Continue as is	800
Zinc, total	0.03	Continue as is	0.03
Water temperature (C)	[3]30.0	Continue as is	[3]30.0
pH (units)	[4]6.5	Continue as is (need to determine what is natural)	[4]6.5
Coliform (no./100 mL)			
Fecal	2,000	Discontinue	--
Total	20,000	Discontinue	--

Units in mg/L except as noted.

1. Five-year average of flow-weighted concentrations (March to October) should be <2.5 boron, <1000 TDS. Three-month average of flow-weighted concentration should be <3.5 boron and <1500 TDS.
2. 5.0 (minimum April 10 to May 15), 4.0 (minimum remainder of year).
3. Natural temperature (April 10 to May 15), <30 degrees Celsius (remainder of year).
4. Less than 0.5 pH units above natural, minimum pH = 6.5.

2.4 Data Exchange

The Committee is responsible for assuring exchange of data between governments. The exchange of monitoring information was initiated in the first quarter of 1981 and was an expansion of the informal quarterly exchange program initiated between the United States and Canada in 1976. Until 1991, data were exchanged on a quarterly basis. At the request of the Committee, the United States and Canada agreed to replace the quarterly exchange of data with an annual exchange effective at the beginning of the 1992 calendar year.

Henceforth, data will be exchanged once each year as soon after the end of the calendar year as possible. However, unusual conditions or anomalous information will be reported and exchanged whenever warranted. No unusual conditions occurred during 1992 which would warrant special reporting.

3.0 WATER AND AIR: MONITORING AND INTERPRETATIONS

3.1 Poplar River Power Station Operation

In 1992, the average capacity factor for Unit No. 1 was 92.8 percent. The average capacity factor for Unit No. 2 was 88.2 percent. The capacity factors are based on the maximum power generation rating of 297.8 MW/h for Unit No. 1 and 294 MW/h for Unit No. 2. Total power generated from both units was 4 692 000 gross megawatt-hours which is about 103 percent of 1991 power and 102 percent of 1990 power.

3.2 East Poplar River

3.2.1 Streamflow

Streamflow in the Poplar River basin was below normal in 1992. The March to October recorded flow of the Poplar River at the International Boundary, an indicator of natural flow in the basin, was 2 080 cubic decametres which was 21 percent of the 1931 to 1991 median seasonal flow. For the

sixth consecutive year, the flow was below normal. A comparison of 1992 monthly mean discharge with the 1961-90 median discharge is shown in Figure 3.1.

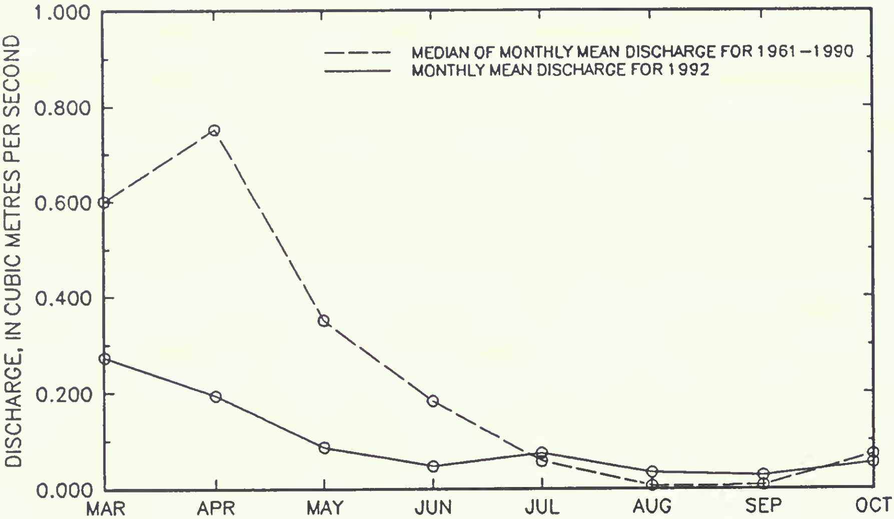


Figure 3.1 **Discharge during 1992 as Compared with the Median Discharge from 1961-1990 for the Poplar River at the International Boundary.**

The 1992 recorded flow volume of the East Poplar River at the International Boundary was 1 860 dam^3. This volume is 54 percent of the median annual flow since the completion of Morrison Dam in 1975.

3.2.2 Apportionment

In 1976 the International Souris-Red Rivers Engineering Board, through its Poplar River Task Force, completed an investigation and made a recommendation to the governments of Canada and the United States regarding the apportionment of waters of the Poplar River basin. Although not officially adopted by the two countries, the Poplar River Bilateral Monitoring Committee has adhered

to the Apportionment Recommendations in each of its annual reports. Annex 3 contains the apportionment recommendation.

3.2.3 Minimum Flows

The recorded volume of the Poplar River at the International Boundary from March 1 to May 31, 1992 was 1 460 dam^3. Based on IJC recommendations and the assumption that the recorded flow is the natural flow, the United States was entitled to a minimum discharge on the East Poplar River of 0.028 cubic metres per second (m^3/s) for the period June 1, 1992 to May 31, 1993. The minimum flow for the period January 1 to May 31, 1992 had previously been determined on the basis of the Poplar River flow volume for March 1 to May 31, 1991. A hydrograph for the East Poplar River at the International Boundary and the minimum flow as recommended by the IJC are shown in Figure 3.2. Daily flows during 1992 were above the recommended minimum at all times with the exception of December 29, 30, 31, 1992. Extremely cold temperatures reduced the flow to 0.027 m^3/s on these days.

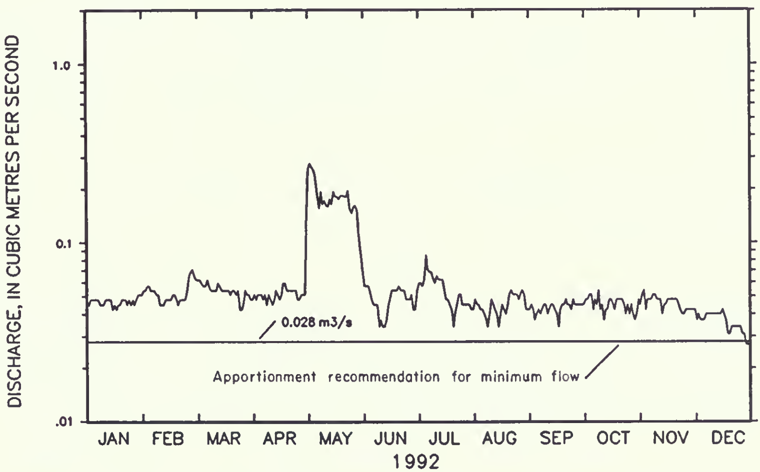


Figure 3.2 **Flow Hydrograph of the East Poplar River at the International Boundary.**

3.2.4 On-Demand Release

In addition to the minimum flow, the IJC apportionment recommendation entitles Montana to an on-demand release to be delivered during the twelve month period commencing June 1, 1991. Based on the runoff volume recorded at the Poplar River at the International Boundary gaging station during the March 1 to May 31, 1991 period, Montana was entitled to a release of 370 dam^3 from Cookson Reservoir. Montana requested this release to be made between May 1 and May 30, 1992. A volume of 480 dam^3 was delivered during this period.

3.2.5 Water Quality

The 1981 report by the IJC to Governments recommended:

> ***For the March to October period, the maximum flow-weighted concentrations should not exceed 3.5 milligrams per liter (mg/L) for boron and 1 500 mg/L for total dissolved solids for any three consecutive months in the East Poplar River at the International Boundary. For the March to October period, the long-term average of flow-weighted concentrations should be 2.5 mg/L or less for boron, and 1 000 mg/L or less for total dissolved solids in the East Poplar River at the International Boundary.***

The Bilateral Monitoring Committee adopted the approach that, for the purposes of comparison with the proposed IJC long-term objectives, the boron and total dissolved solids (TDS) data are best graphically plotted as 5-year moving flow-weighted concentrations (FWCs) which were advanced one month at a time.

3.2.5.1 Total Dissolved Solids

TDS data for grab samples collected by Environment Canada and the U.S. Geological Survey in 1992 are shown in Figure 3.3. TDS ranged from 743 mg/L (March 16) to 1 286 mg/L (May 19). The short-term objective for TDS is 1 500 mg/L. A time plot of the 3-month moving FWCs for TDS is presented in Figure 3.4. No exceedances of the objective have been observed during any 3-month period since 1975. The 3-month FWCs remained confined within a narrow range centered around a mean of approximately 1 000 mg/L during 1992.

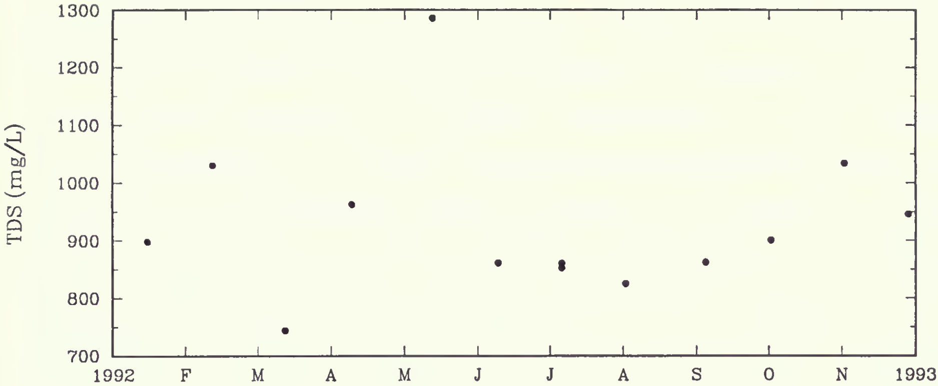


Figure 3.3 TDS Concentrations for 1992 Grab Samples from East Poplar River at International Boundary.

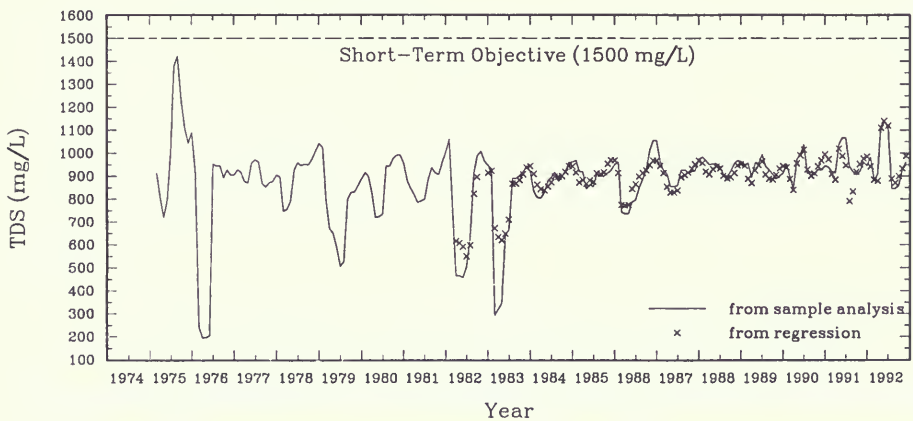


Figure 3.4 Three-Month Moving, Flow-Weighted TDS Concentration for East Poplar River at International Boundary.

Five-year FWCs for TDS (Figure 3.5) remained below the long-term objective of 1 000 mg/L. An increase in the 5-year FWCs to approximately 955 mg/L was observed in 1992. A 200-mg/L increase had previously occurred in early 1988 and had been maintained through 1989 and 1990. The 1991 rise in FWCs corresponds to depressed spring flows in the East Poplar River. A similar increase in TDS was seen during mid-1987. Relatively low spring discharges have occurred since 1984. If this trend continues, it is expected that FWCs will reach the 1 000 mg/L objective. The TDS increase can be explained in part by salt build-up in Cookson Reservoir as a result of water being used for cooling. Forced evaporation causes salts to concentrate within the reservoir. This process is further driven by drought conditions which prevailed over the last half of the data record (Lang and Jones, 1988). In addition, low-flow conditions (when flows are derived largely from ground-water sources) likely increase TDS concentrations and yields a positive TDS trend in the data.

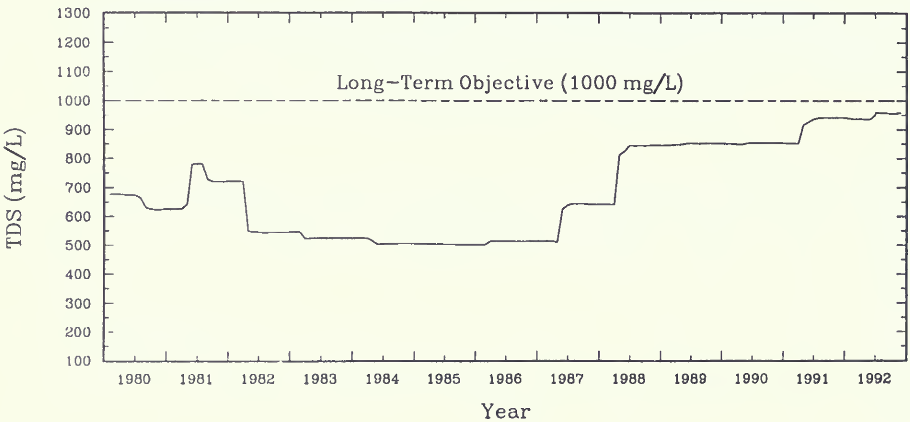


Figure 3.5 **Five-Year Moving, Flow-Weighted TDS Concentration for East Poplar River at International Boundary.**

The relation between TDS and specific conductance generated from data collected from 1975 to 1992 is as follows:

$$\mathbf{TDS = (0.632 \times specific\ conductance) + 19.97}$$
$$\mathbf{(R^2 = 0.86,\ n = 449)}$$

3.2.5.2 Boron

During 1992, boron concentrations in the East Poplar River at the International Boundary varied from 1.40 mg/L (March 16) to 2.34 mg/L (May 19) (Figure 3.6).

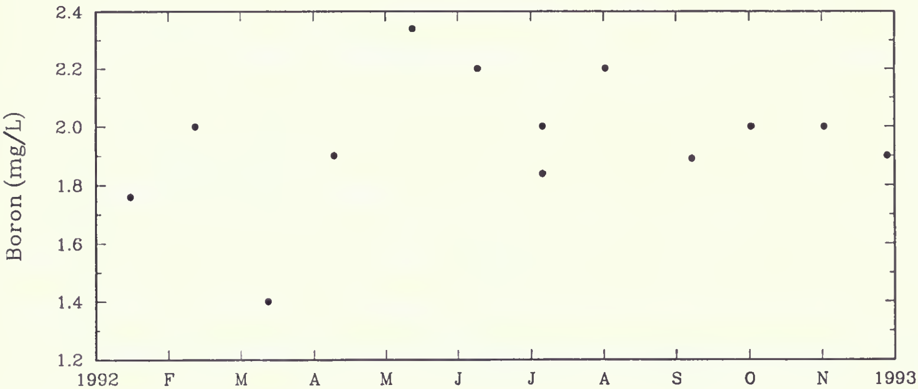


Figure 3.6 **Boron Concentrations for 1992 Grab Samples from East Poplar River at International Boundary.**

Three-month boron FWCs for the period of record are shown in Figure 3.7. The short-term objective of 3.5 mg/L boron was not exceeded for the period 1975-1992. The similarity in shape between the TDS and boron plots (Figures 3.4 and 3.7) is a strong indication of the influence of discharge on FWC functions.

The 5-year boron FWCs, displayed in Figure 3.8, remained well below the long-term objective of 2.5 mg/L boron. From mid-1988 to the end of 1990, there was a slight increase in the 5-year boron FWC. The 5-year boron FWC increased slightly from 1.90 mg/L in 1991 to approximately 1.95 mg/L. The 5-year calculations for boron were significantly influenced by discharge in exactly the same way as was TDS.

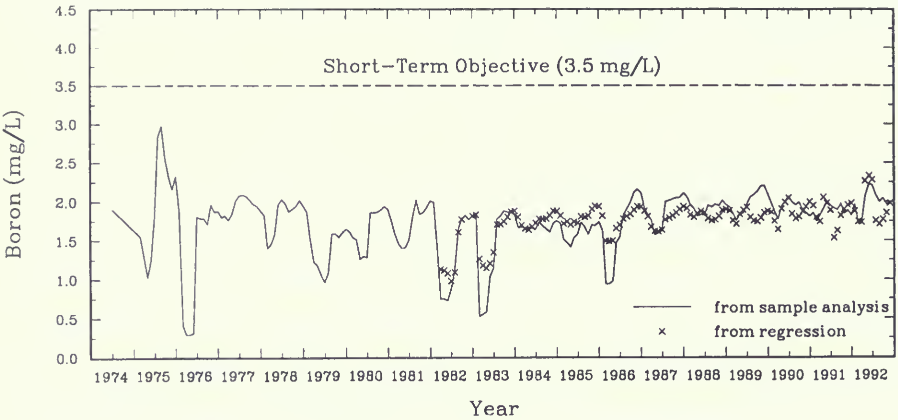


Figure 3.7 **Three-Month Moving, Flow-Weighted Boron Concentration for East Poplar River at International Boundary.**

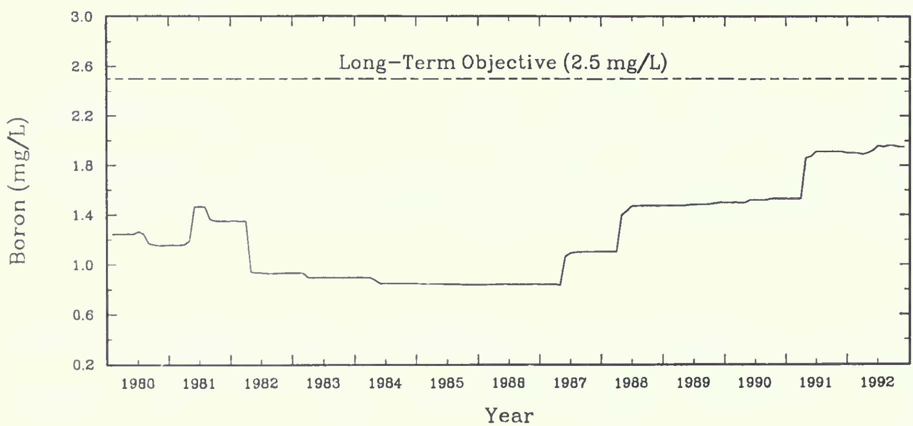


Figure 3.8 **Five-Year Moving, Flow-Weighted Boron Concentration for East Poplar River at International Boundary.**

The relation between boron and specific conductance at the East Poplar River sampling location during the period 1975-1992 is described by the equation:

$$\textbf{boron - (0.00144 x specific conductance) - 0.218}$$
$$(R^2 = 0.69, n = 449)$$

The increase in boron, as was the case with TDS, can be explained by evaporative loss of water brought on by the drought conditions and the use of water for cooling, both intensifying natural evaporation from Cookson Reservoir.

3.2.5.3 Other Water-Quality Variables

Table 3.1 lists the multipurpose water-quality objectives for the East Poplar River in the International Boundary, recommended by the International Poplar River Water Quality Board to the IJC. A single excursion of the multipurpose objectives occurred in 1992. On January 15th, a dissolved oxygen measurement of 2.4 mg/L was below the 4.0 mg/L objective. It is believed that extensive ice cover, coupled with low-flow conditions, drastically inhibited the aeration process.

Environment Canada monitored the East Poplar River for phenoxy acid herbicides and organochlorine compounds during 1992. Trace concentrations of 2,4-D (in two of five samples), γ-BHC (in one of five samples), α-BHC (in one of five samples) and Dicamba (in one of five samples) were recorded. The presence of these compounds in prairie surface waters is well documented (Integrated Environments Limited, 1991). All other organic compounds monitored were below analytical detection limits.

Table 3.1 Recommended Water-Quality Objectives and Excursions, 1992 Sampling Program, East Poplar River at International Boundary

Parameter	Objective	No. of Samples		Excursions
		USA	Canada	
Objectives recommended by IJC to Governments				
Boron, total	[1]3.5/2.5	7	10	Nil
Total Dissolved Solids	[1]1500/1000	7	10	Nil
Objectives recommended by International Poplar River Water Quality Board to IJC				
Aluminum, dissolved	0.1	4	6	Nil
Ammonia un-ionized (as N)	0.2	6	10	Nil
Cadmium, total	0.0012	4	10	Nil
Chromium, total	0.05	4	7	Nil
Copper, dissolved	0.005	4	--	Nil
Copper, total	1.0	2	10	Nil
Fluoride, dissolved	1.5	7	10	Nil
Lead, total	0.03	2	10	Nil
Mercury, dissolved	0.0002	--	--	
Mercury, whole fish (mg Hg/Kg)	0.5	--	--	
Nitrate (as N)	10.0	6	10	Nil
Oxygen, dissolved	[2]4.0/5.0	7	6	1
Sodium adsorption ratio	10.0	7	10	Nil
Sulphate, dissolved	800.0	7	10	Nil
Zinc, total	0.03	2	10	Nil
Water Temperature (Celsius)	[3]30.0	7	6	Nil
pH (pH Units)	[4]6.5	7	6	Nil
Coliform, fecal (no. per 100 mL)	2,000	--	10	Nil
Coliform, total (no. per 100 mL)	20,000	--	10	Nil

Units in mg/L except as noted.
1. Three-month average of flow-weighted concentrations should be <3.5 boron and <1,500 TDS. Five-year average of flow-weighted concentrations (March to October) should be <2.5 boron and <1,000 TDS.
2. 5.0 (minimum April 10 to May 15), 4.0 (minimum remainder of year).
3. Natural temperature (April 10 to May 15), <30 degrees Celsius (remainder of year).
4. Less than 0.5 pH units above natural, minimum pH = 6.5.

3.3 Ground Water

3.3.1 Operations

In 1992, as part of the Supplementary Water Supply Project, 21 wells were in operating status. Operation of these wells resulted in a total of 5 225 dam^3 of ground water being pumped. A regional network of 171 piezometers was monitored as part of this project.

Currently, there are eight pump wells installed as part of the Soil Salinity Project. These wells produced a total of 942 dam^3. However, 95 percent of this water was produced from PW87103 and PW87104 on the east side of the East Poplar River and PW90108 on the west side of the East Poplar River.

3.3.2 Ground-Water Levels

3.3.2.1 Saskatchewan

As can be seen in figure 3.9, there appears to have been a slight general expansion in the cone of depression in 1992. Of particular note is the expansion of the cone along the Montana border. The cone has shifted south only slightly, but it has spread out along the border. As a result, the 1-metre drawdown contour is approaching the border along a front from Section 1, Township 1, Range 27, West of 2, to Section 1, Township 1, Range 28, West of 2, and in places is less than 1 kilometre from the border. This change may be due in part to the replacement of border piezometers M506 and M510. The old piezometers were not yielding reliable data which probably influenced the interpretation of previous drawdown maps. Based on the drawdowns seen on the 1992 map, it is clear that some drawdown will be occurring along the border in Montana. However, these drawdowns are estimated to be less than 1 metre. This confirms the drawdowns noted by state officials in Montana in piezometers they measured in 1991.

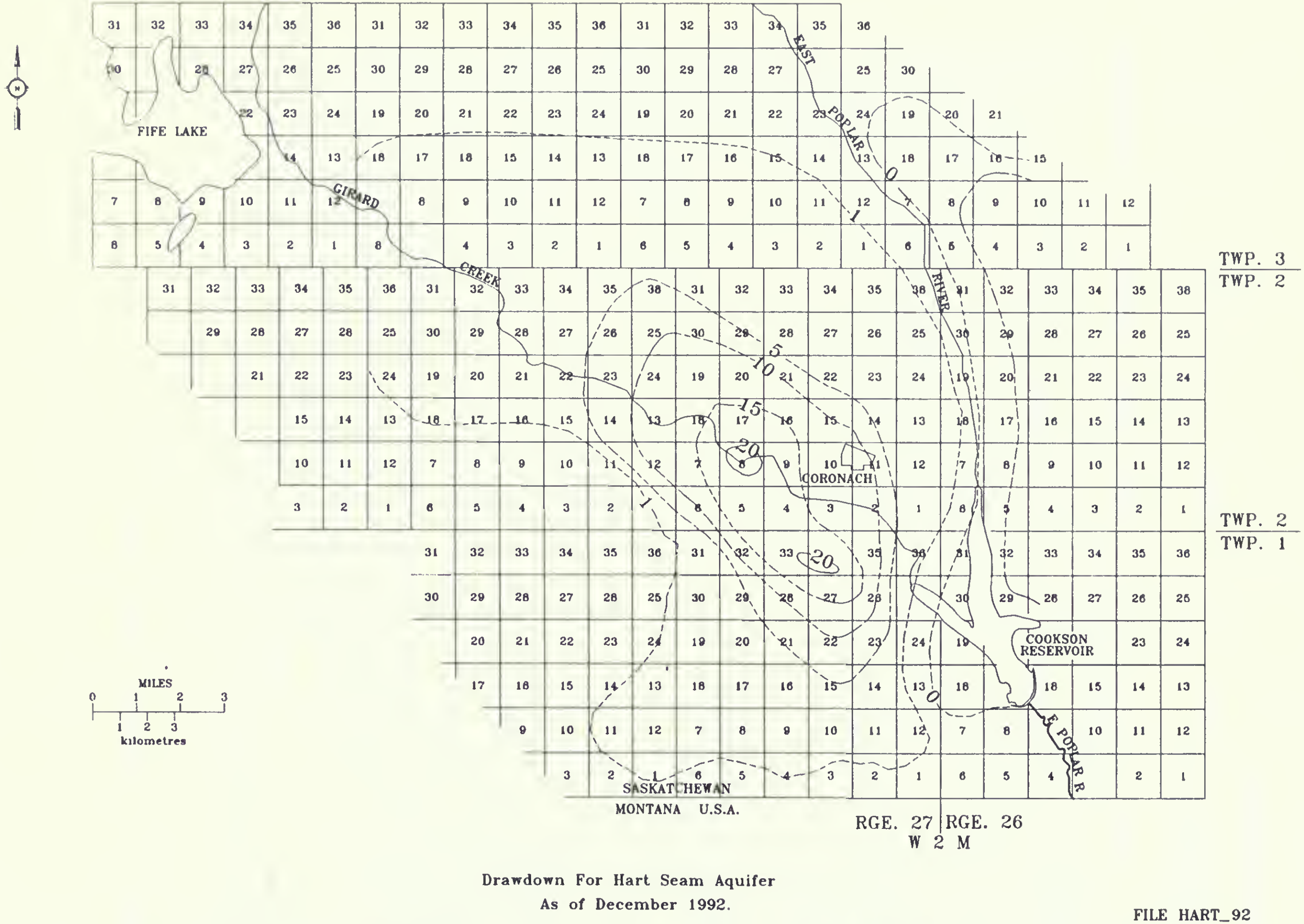


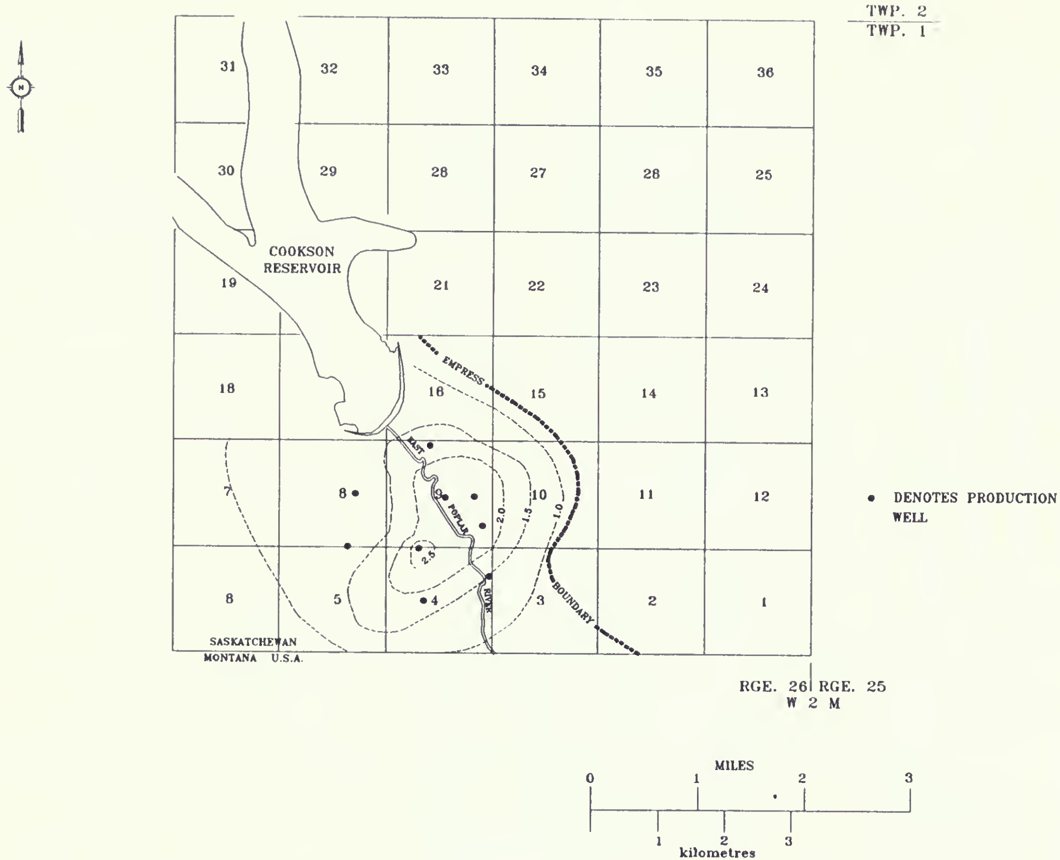
Figure 3.9 Drawdown for Hart Seam Aquifer as of December 1992.

Figure 3.10 illustrates the extent and magnitude of the cone of depression in the Empress Sands as a result of the Soil Salinity Project. The pumpage is resulting in drawdowns of approximately 1 metre at the International Boundary in Sections 4, 5, and possibly 3, of Township 1, Range 26, West of 2. The projected goal for achieving drawdowns in the order of 2 to 3 metres has now been achieved, and therefore future pumping should be relatively stable subject to water levels in Cookson Reservoir.

3.3.2.2 Montana

During 1992, water levels continued to decline in monitoring wells located in Montana with the exception of wells 2, 8-9, 11, and 21. At the International Boundary, water levels have declined approximately 0.6 metres in wells 5 and 6 and about 1 metre in well 10. Well 10 is responding to pumpage from the Hart coal seam and probably pumpage from Soil Salinity Project wells along the East Poplar River downstream from Morrison Dam.

Hydrographs of selected wells which monitor water levels in the Hart coal seam are shown in figure 3.11.



Cone of Depression in the Empress Sands Due To The Salinity Project as of December 1992. Contour intervals in metres.

Figure 3.10 Cone of Depression in the Empress Sands Due to the Salinity Project as of December 1992.

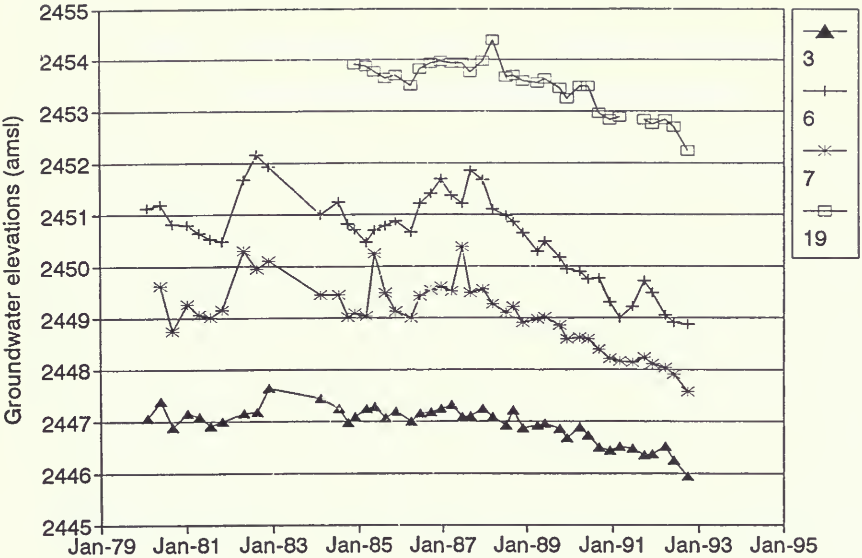


Figure 3.11 Hydrographs of Selected Wells.

3.3.3 Ground-Water Quality

3.3.3.1 Saskatchewan

The water quality from the Supplementary Water Supply Project discharge points has been consistent with no trends indicated. A summary of the more frequently tested parameters during 1992 is provided in Table 3.2. Statistical averages of the results since January 1990 are included in this table.

Table 3.2 Water-Quality Statistics for Water Pumped from Supplementary Water Supply Project Wells Sampled at Site "C3" on Girard Creek.

	1990-1991 Average	1992 Average
pH (units)	7.7	7.8
Conductivity (µS/cm)	1,383	1,381
Total dissolved solids	905	930
Total suspended solids	3.7	2.6
Boron	1.25	1.29
Sodium	178	180
Cyanide (µg/L)	<2	<2
Iron	1.2	1.4
Manganese	0.24	0.23
Mercury (µg/L)	<0.10	<0.1
Units in mg/L except as noted.		

Girard Creek location "C3" is directly downstream from the majority of the pumped wells and provides a good indication of water quality entering Cookson Reservoir. Water quality at "C3" is better than current reservoir quality and therefore this water has a positive influence on the quality of water in the reservoir.

The water quality of the common discharge point from the Soil Salinity Project wells is generally better than the water quality in Cookson Reservoir. Average results from the common discharge point for 1992, plus a summary of the 1990 and 1991 results, are provided in Table 3.3. Results have been consistent since 1990.

Table 3.3 Water-Quality Statistics for Water Pumped from Soil Salinity Project Wells Sampled at the Discharge Pipe.

	1990-1991 Average	1992 Average
pH (units)	7.7	7.8
Conductivity (μS/cm)	1,457	1,388
Total dissolved solids	966	941
Boron	1.5	1.7
Calcium	111	98
Magnesium	60	58
Sodium	147	151
Potassium	7.4	7.6
Arsenic (μg/L)	13.1	15.3
Aluminum	0.011	0.012
Barium	0.025	0.028
Cadmium	<0.001	<0.001
Iron	3.8	4.2
Manganese	0.31	0.15
Molybdenum	0.003	0.003
Strontium	1.70	1.86
Vanadium	0.003	0.002
Uranium (μg/L)	<0.1	<0.1
Mercury (μg/L)	<0.10	<0.1
Sulfate	328	315
Units in mg/L except as noted.		

Ground-water quality can potentially be affected by seepage of the contaminants in the ash lagoons through the containment system. The piezometers listed in the Technical Monitoring Schedules are

used to detect leachate movement and calculate seepage rates. In 1992, 15 new piezometers were installed to obtain additional information on leachate effects and seepage from the ash lagoons.

The piezometric surface for the oxidized strata shows a ground-water mound that has developed beneath the ash lagoons. The ground-water mound extends from the east side of Ash Lagoon No. 2, where a 6-metre increase has been noted, to the west side of the Polishing Pond, where levels have increased about 4 metres. The new oxidized-till piezometers installed along Dyke B confirm the ground-water mound that has developed. The oxidized-till piezometers closer to the reservoir have shown a decreasing trend in piezometric levels reacting to lower reservoir water levels.

The largest changes in chloride and boron concentrations have occurred where the water levels have changed the most. This would be expected because changing water levels suggest leachate movement. Increasing boron concentrations on the east and south sides of Ash Lagoon No. 2, together with decreasing chloride concentrations, suggests leachate influence. On the west side of the Polishing Pond, boron concentrations have not changed significantly.

Little change in boron or chloride concentrations has been noticed in samples from most of the oxidized-till piezometers located by the reservoir. The only significant change in samples from any of these piezometers has been at C719 where chloride concentrations have decreased by 96 mg/L since 1983, to a concentration of 14.7 mg/L in 1992. This piezometer is beside the reservoir and the change in quality is due to the lower water levels of the reservoir rather than ash-lagoon influence.

During the 1991 review, a ground-water mound was concluded to have developed in the unoxidized till similar to that in the oxidized till, extending from the east side of Ash Lagoon No. 2 to the west side of the Polishing Pond. The ground-water mound was known not to be continuous because some unoxidized-till piezometers within the mound area had no increase in piezometric level. The new piezometers installed along Dyke B (C868C, C869C, and C871C) provided some valuable information. These piezometers located in the middle of the lagoon area are illustrating a

decreasing trend in piezometric levels matching decreasing reservoir levels. This new information would suggest that the ground-water mound in the unoxidized till is not general but likely occurs in unconnected pockets. A review of boron and chloride concentrations does not show any strong trends.

The piezometric surface of the Empress gravels indicate a regional flow from northwest to southeast below Morrison Dam. Since 1983, the closer an Empress piezometer is to the reservoir, the larger the decrease in water level. Around the lagoon area there is a noticeable drop in piezometric level at the north end of Ash Lagoons No. 1 and No. 2, and a mound has developed at the east end of Ash Lagoon No. 3 North. The mound on the east side of Ash Lagoon No. 3 North is likely due to upper horizon influences. Results for the Empress gravel do not indicate any seepage activity with the majority of piezometer wells showing little change in boron or chloride concentrations.

Piezometer series C775 is located at the southeast comer of Ash Lagoon No. 3 North. Until 1992, chloride concentrations have only varied in samples from the oxidized-till piezometer C775A. For the last two years, water levels in the oxidized-till piezometer C775B, the unoxidized-till piezometer C775C, and the Empress-gravel piezometer C775D have increased. This is especially significant in C775B where the level has increased 6 metres in the last year and boron concentration has increased to 6.6 mg/L in 1992. The changes seen for the piezometers in the area are significant but more data will be needed to reach any firm conclusions.

Sand-lense piezometers C712B, C766, and C767 are located between the Polishing Pond and the cooling water canal. C767 is located on top of Dyke G. C766 and C712B are located at the top of Dyke G.

A review of the boron concentrations for samples from C766 shows an increasing trend until October 1988 when levels peaked at 12.6 mg/L. Boron concentration decreased to 6.99 mg/L in April 1990,

started increasing again, and peaked at 23.7 mg/L at the end of 1991. In 1992, the boron concentrations remained stable at about 25 mg/L.

Until April 1988, the boron concentration for samples from C767 was increasing and peaked at 49.4 mg/L. From this peak, the boron concentration has steadily decreased. By the end of 1991 the boron concentration had leveled off below 4 mg/L and remained at this concentration through 1992. The reduction in boron concentrations for samples from C767 to background concentrations suggest a leachate plume and not a continuous front.

Piezometer C712B has been monitored for several years. Historically, boron concentrations have been below 1 mg/L. In mid-1987, increasing boron concentrations were noted with the concentration peaking in April 1992 at 26.6 mg/L.

Chloride concentrations trended down in samples from C712B to 50 mg/L in 1988 from over 200 mg/L in 1984. Since 1988, chloride concentrations have changed little with the exception of a spike over 125 mg/L in 1991. There is an increasing trend in samples from piezometer C767, increasing from about 25 mg/L in 1989 to 75 mg/L in 1991. Since 1991, the chloride concentrations in samples from C767 have remained about 75 mg/L. The chloride concentrations for samples from C766 have shown little change since 1987 and remain between 20 and 30 mg/L, similar to ash-lagoon chloride concentrations. The lag time for the boron concentration to increase when compared to chloride is expected because boron moves slower through soil than an element like chloride. The higher boron concentrations in samples from C767 than in samples from the other two piezometers are much closer to the boron concentrations in the Polishing Pond.

The total calculated seepage from the ash lagoon was determined to be 1.51 L/s. This is an increase over the 1991 calculated value of 1.267 L/s.

The increase can mostly be attributed to the increase in calculated seepage rates for Ash Lagoon No. 1 from 0.245 L/s in 1991 to 0.417 L/s in 1992. The piezometric levels in the new piezometers

installed on the west side of Ash Lagoon No. 1 closely matched levels in other piezometers on the west side of the ash lagoons and these levels did not affect calculations. However, the new piezometers on the east side of Ash Lagoon No. 1 did indicate large increases in piezometric levels from background values and when these levels were added to the calculation, the calculated seepage rates increased. The piezometers on the east side of Ash Lagoon No. 1 provided data in an area where there was no previous information. Calculated liner permeabilities for the ash lagoons have remained about 10^{-9} cm/sec.

The calculated total seepage from the ash lagoons is well below the seepage limits proposed in 1979 by the International Poplar River Water Quality Board of the International Joint Commission.

3.3.3.2 Montana

Samples for water-quality analysis were collected from Montana monitoring wells 5-11, 15, 16, 19, 23, and 24 in 1992. Graphs of total dissolved solids for selected wells are shown in Figure 3.12.

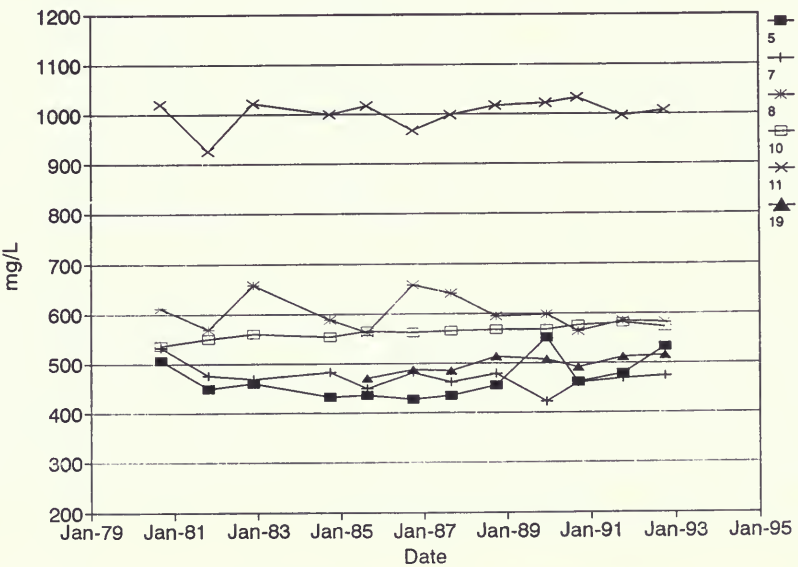


Figure 3.12 Total Dissolved Solids in Samples from Montana Monitoring Wells.

3.4 Cookson Reservoir

3.4.1 Storage

On January 1, 1992, Cookson Reservoir storage was 23 500 dam^3--54 percent of the full-supply volume. During the year, precipitation was below normal resulting in below normal inflows. The 1992 maximum, minimum, and period elevations and volumes are shown in Table 3.4. In addition to runoff, reservoir levels were augmented by ground-water pumpage. Wells in the abandoned west block mine site supplied 5 225 dam^3 to Girard Creek. Approximately 70 percent of this flow volume reached Cookson Reservoir. Wells in the Soil Salinity Project supplied 942 dam^3 directly to the reservoir.

Table 3.4 Cookson Reservoir Storage Statistics for 1992.

Date	Elevation (m)	Contents (dam^3)
January 1	749.944	23 500
March 3 (maximum)	749.989	23 800
October 14 (minimum)	749.085	19 500
December 31	749.116	19 800
Full-supply level	753.000	43 400

The Poplar River Power Station is dependent on water from Cookson Reservoir for cooling. Power plant operation is adversely affected when reservoir levels drop below 749.0 metres. The dead-storage level for cooling water used in the generation process is 745.0 metres. The 1992 recorded levels and associated operating levels are shown in Figure 3.13. As indicated in Figure 3.13, 1992 reservoir levels were well below the ten-year median levels.

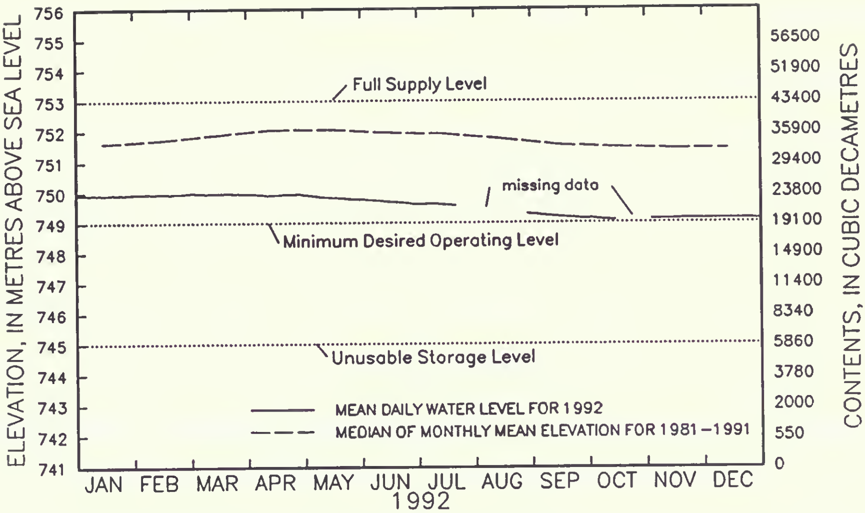


Figure 3.13 Cookson Reservoir Mean Daily Water Levels for 1992 and Median Monthly Water Levels for 1981-1991.

3.4.2 Water Quality

For the last several years, the lack of normal spring runoff has been the most significant factor influencing Cookson Reservoir water quality. During 1992, Cookson Reservoir did not experience boron concentrations in excess of 3.5 mg/L. However, the reservoir water quality exceeded 1 500 mg/L for total dissolved solids.

The net effect of little spring runoff over the last several years has been a decrease in reservoir water quality. From 1988 to the end of 1992, several analytes have doubled in concentration; sulfate, sodium, and boron, for example. The reservoir water quality has decreased to the point that a substantial spring runoff will be required to have any significant impact on the reservoir quality.

3.5 Air Quality

3.5.1 Saskatchewan Environment and Resource Management

Ambient sulphur dioxide (SO_2) monitoring was discontinued on March 30, 1992. During the 3-month period of 1992, ambient sulphur dioxide monitoring recorded no violations of Saskatchewan Environment and Resource Management's hourly and 24-hour average standards of 0.17 and 0.06 parts per million (ppm), respectively. The highest recorded hourly value of 0.082 ppm SO_2 was recorded on March 27th at 13:00 hours, as compared to 0.137 ppm SO_2 recorded in September 1991. The highest 24-hour average reading of 0.011 ppm occurred on March 27th as compared with 1991's highest average reading of 0.11 ppm. There was no downtime for the monitor during the 3-month period.

The High-Volume Sampler was also discontinued on March 30, 1992. Suspended particulate concentrations obtained from the monitor at the same site for the 3-month period did not exceed Saskatchewan Environment and Resource Management's 24-hour average standard of 120 micrograms per cubic metre ($\mu g/m^3$) per 24 hours as compared to the two occasions in 1991 in September and October at 162.2 $\mu g/m^3$, and 197.7 $\mu g/m^3$ respectively. The annual geometric mean was not calculated for 1992 and there was no downtime for the 3-month period as compared to 3.3 percent downtime for 1991.

3.5.2 SaskPower Corporation

SaskPower Corporation's (SPC) ambient SO_2 monitoring for 1992 recorded no violations of Saskatchewan Environment and Resource Management's hourly and 24-hour average standards. The highest recorded hourly value of 0.067 ppm SO_2 was recorded on October 9, 1992 at 11:00 hours.

Total suspended particulate concentrations for 1992 obtained from SPC's monitor exceeded Saskatchewan's 24-hour standard of 120 $\mu g/m^3$ on three separate occasions: April 12th (246.4 $\mu g/m^3$), April 30th (318.6 $\mu g/m^3$), and May 8 (363.6 $\mu g/m^3$). In all cases, the prevailing wind direction eliminated the power station as a possible influence. The geometric mean for the high-volume air sampler for 1992 was 23.8 $\mu g/m^3$.

3.6 Quality Control

3.6.1 Streamflow

To test the quality of streamflow calculations made by the U.S. Geological Survey (USGS) and Environment Canada (EC), similar measurements were made on the East Poplar River at the International Boundary on June 17, 1992 by personnel from both agencies. The discharges shown in Table 3.5 agree within measurement error.

Table 3.5 Streamflow Measurement Results for June 17, 1992.

Agency	Time CST	Width (m)	Mean Area (m^2)	Velocity (m/s)	Gauge Height (m)	Discharge (m^3/s)
EC	09:00	1.4	0.143	0.369	1.527	0.053
USGS	08:30	1.4	0.131	0.369	1.524	0.048

3.6.2 Water Quality

Quality-control sampling was carried out at the East Poplar River at the International Boundary on July 15, 1992. Participating agencies included in the U.S. Geological Survey, Environment Canada, Saskatchewan Environment and Resource Management, and SaskPower Corporation.

Sets of triplicate samples were split from U.S. Geological Survey sampling chums and submitted to the respective agency laboratories for analyses. Field procedures were identical to those used since 1986.

Most parameters showed acceptable reproducibility within and between sets of triplicates. Only the variables for which corrective action should be considered are discussed here.

Field temperature results showed an unacceptable level of inter-agency variability with values ranging from 16.5 ^{o}C to 18.0 ^{o}C. Dissolved-oxygen concentrations ranged from 10.0 to 11.2 mg/L.

Between-triplicate results were not comparable for ortho phosphorus, total ammonia, chloride, total barium, total vanadium, and dissolved iron.

For TDS, dissolved iron, dissolved boron, silica, total chromium and color, one set of results was noticeably high compared to the other reported sets. Similarly, one of the reported triplicate data sets was low for lab pH.

Since most of the metals were present in the samples at concentrations near or below analytical detection limits, a satisfactory evaluation of data comparability for these constituents is not possible.

4.0 REFERENCES CITED

Integrated Environments Limited, 1991, The use of the TYDAC SPANS GIS in the assessment and review of pesticide residues detected in surface waters of the Prairie Provinces and the Northwest Territories. (Prepared for Environment Canada, Inland Waters Directorate, Western and Northern Region, Water Quality Branch, Regina, Saskatchewan.) 138 p.

Lang, T.-A., and Jones, K., 1988, A comparison of the meteorological conditions during the droughts of the 1930's and the 1980's for the Prairie Provinces. Environment Canada, Atmospheric Environment Service, Regina. Report No. CSS-R89-01 (A publication of the Canadian Climate Program.) 50 p.

ANNEX 1

POPLAR RIVER

COOPERATIVE MONITORING ARRANGEMENT

CANADA-UNITED STATES

September 23, 1980

POPLAR RIVER COOPERATIVE MONITORING ARRANGEMENT

I. PURPOSE

This Arrangement will provide for the exchange of data collected as described in the attached Technical Monitoring Schedules in water quality, water quantity and air quality monitoring programs being conducted in Canada and the United States at or near the International Boundary in response to SaskPower development. This Arrangement will also provide for the dissemination of the data in each country and will assure its comparability and assist in its technical interpretation.

The Arrangement will replace and expand upon the quarterly information exchange program instituted between Canada and the United States in 1976.

II. PARTICIPATING GOVERNMENTS

Governments and government agencies participating in the Arrangement are:

Government of Canada: Environment Canada
Government of the Province of Saskatchewan:
Saskatchewan Environment and Public Safety (now Saskatchewan Environment and Resource Management)
Government of the United States of America: U.S Geological Survey
Government of the State of Montana: Executive Office

III. POPLAR RIVER MONITORING COMMITTEE: TERMS OF REFERENCE

A binational committee called the Poplar River Bilateral Monitoring Committee will be established to carry out responsibilities assigned to it under this Arrangement. The Committee will operate in accordance with the following terms of reference:

A. Membership

The Committee will be composed of four representatives, one from each of the participating Governments. It will be jointly chaired by the Government of Canada and the Government of the United States. There will be a Canadian Section and a United States Section. The participating Governments will notify each other of any changes in membership on the Committee. Co-chairpersons may by mutual agreement invite agency technical experts to participate in the work of the Committee.

The Governor of the State of Montana may also appoint a chief elective official of local government to participate as an ex-officio member of the Committee in its technical deliberations. The Saskatchewan Minister of the Environment may also appoint a similar local representative.

B. Functions of the Committee

The role of the Committee will be to fulfill the purpose of the Arrangement by ensuring the exchange of monitored data in accordance with the attached Technical Monitoring Schedules, and its collation and technical interpretation in reports to Governments on implementation of the Arrangement. In addition, the Committee will review the existing monitoring systems to ensure their adequacy and

may recommend to the Canadian and United States Governments any modifications to improve the Technical Monitoring Schedules.

1. Information Exchange

Each Co-chairperson will be responsible for transmitting to his counterpart Co-chairperson on a regular, and not less than quarterly basis, the data provided by the cooperative monitoring agencies in accordance with the Technical Monitoring Schedules.

2. Reports

(a) The Committee will prepare a joint Annual Report to the participating governments, and may at any time prepare joint Special Reports.

(b) Annual Reports will

i) summarize the main activities of the Committee in the year under Report and the data which has been exchanged under the Arrangement;

ii) draw to the attention of the participating governments any definitive changes in the monitored parameters, based on collation and technical interpretation of exchanged data (i.e. the utilization of summary, statistical and other appropriate techniques);

iii) draw to the attention of the participating governments any recommendations regarding the adequacy or redundancy of any scheduled monitoring operations and any proposals regarding modifications to the Technical Monitoring Schedules, based on a continuing review of the monitoring programs including analytical methods to ensure their comparability.

(c) Special Reports may, at any time, draw to the attention of participating governments definitive changes in monitored parameters which may require immediate attention.

(d) Preparation of Reports

Reports will be prepared following consultation with all committee members and will be signed by all Committee members. Reports will be separately forwarded by the Committee Co-chairmen to the participating governments. All annual and special reports will be so distributed.

3. Activities of Canadian and United States Sections

The Canadian and United States sections will be separately responsible for:

(a) dissemination of information within their respective countries, and the arrangement of any discussion required with local elected officials;

(b) verification that monitoring operations are being carried out in accordance with the Technical Monitoring Schedules by cooperating monitoring agencies;

(c) receipt and collation of monitored data generated by the cooperating agencies in their respective countries as specified in the Technical Monitoring Schedules;

(d) if necessary, drawing to the attention of the appropriate government in their respective countries any failure to comply with a scheduled monitoring function on the part of any cooperating agency under the jurisdiction of that government, and requesting that appropriate corrective action be taken.

IV. PROVISION OF DATA

In order to ensure that the Committee is able to carry out the terms of this Arrangement, the participating governments will use their best efforts to have cooperating monitoring agencies, in their respective jurisdictions provide on an ongoing basis all scheduled monitored data for which they are responsible.

V. TERMS OF THE ARRANGEMENT

The Arrangement will be effective for an initial term of five years and may be amended by agreement of the participating govemments. It will be subject to review at the end of the initial term and will be renewed thereafter for as long as it is required by the participating govemments.

ANNEX 2

POPLAR RIVER

COOPERATIVE MONITORING ARRANGEMENT

TECHNICAL MONITORING SCHEDULES

1993

CANADA-UNITED STATES

TABLE OF CONTENTS

PREAMBLE

The Technical Monitoring Schedule lists those water quantity, water quality, and air quality monitoring locations and parameters which form the basis for information exchange and reporting to Governments. The structure of the Committee responsible for ensuring the exchange takes place is described in the Poplar River Cooperative Monitoring Arrangement.

The monitoring locations and parameters listed herein have been reviewed by the Poplar River Bilateral Monitoring Committee and represent the basic technical information needed to identify any definitive changes in water quantity, water quality, and air quality at the International Boundary. The Schedule was initially submitted to Governments for approval as an attachment to the 1981 report to Governments. Changes in the sampling locations and parameters may be made by Governments based on the recommendation of the Committee.

Significant additional information is being collected by agencies on both sides of the International Boundary, primarily for project management or basin-wide baseline data purposes. This additional information is usually available upon request from the collecting agency and forms part of the pool of technical information which may be drawn upon by Governments for specific study purposes. Examples of additional information are data on water quantity, water quality, ground water, and air quality collected at points in the Poplar River basin not of direct concern to the Committee. In addition, supplemental information on parameters such as vegetation, soils, fish, and waterfowl populations and aquatic vegetation is also being collected as part of routine or specific studies by various agencies.

POPLAR RIVER

COOPERATIVE MONITORING ARRANGEMENT

TECHNICAL MONITORING SCHEDULES

1993

CANADA

STREAMFLOW MONITORING

Responsible Agency: Environment Canada

Daily mean discharge or levels and instantaneous monthly extremes as normally published in surface water data publications.

No. on Map	Station No.	Station Name
*1	11AE003 (06178500)	East Poplar River at International Boundary
2	11AE013	Cookson Reservoir near Coronach
3	11AE015	Girard Creek near Coronach above Cookson Reservoir
4	11AE014	East Poplar River above Cookson Reservoir
5	**Fife Lake Overflow	
*6	11AE008 (06178000)	Poplar River at International Boundary

* - International gauging station

**- Miscellaneous measurements of outflow to be made by Sask Water during periods of outflow only.

HYDROMETRIC GAUGING STATIONS (CANADA)

SURFACE-WATER QUALITY MONITORING

Sampling Locations

Responsible Agency: Saskatchewan Environment and Resource Management		
No. on Map	**Station No.**	**Station Name**
1	7904	Fife Lake Overflow
2	12412 Discontinued	Girard Creek at Coronach Reservoir Outflow
3	12377 Discontinued	Upper End of Cookson Reservoir at Highway 36
4	12368	Cookson Reservoir near Dam
5	12386 Discontinued	East Poplar River at Culvert Immediately Below Cookson Reservoir

Responsible Agency: Environment Canada		
No. on Map	**Station No.**	**Station Name**
6	00SA11AE0008	East Poplar River at International Boundary

Responsible Agency: Saskatchewan Environment and Resource Management							
ESQUADAT* Code	Parameter	Analytical Method	Sampling Frequency Station No. 1	2	3	4	5
10151	Alkalinity-phenol	Pot. Titration	OF	Q	Q	Q	Q
10101	Alkalinity-tot	Pot. Titration	OF	Q	Q	Q	Q
13004	Aluminum-tot	AA-Direct		A	A	A	A
33004	Arsenic-tot	Flameless AA		A	A	A	A
06201	Bicarbonates	Calculated	OF	Q	Q	Q	Q
05451	Boron-tot	ICAP	W	Q	Q	Q	Q
48002	Cadmium-tot	AA-Solvent extract (MIBK)		A	A	A	A
20103	Calcium	AA-Direct	OF	Q	Q	Q	Q
06052	Carbon-tot Inorg.	Infrared	OF		Q	Q	Q
06005	Carbon-tot Org.	Infrared	OF		Q	Q	Q
06301	Carbonates	Calculated	OF	Q	Q	Q	Q
17203	Chloride	Automated Colourimetric	OF	Q	Q	Q	Q
06711	Chlorophyll 'a'	Spectrophotometry		Q	Q	Q	Q
24004	Chromium-tot	AA-Direct		A	A	A	A
36012	Coliform-fec	Membrane Filtration	OF	Q	Q	Q	Q
36002	Coliform-tot	Membrane Filtration	OF	Q	Q	Q	Q
02041	Conductivity	Conductivity Meter	W	Q	Q	Q	Q
29005	Copper-tot	AA-Solvent extract (MIBK)		A	A	A	A
09105	Fluoride	Specific ion electrode		A	A	A	A
82002	Lead-tot	AA-Solvent extract (MIBK)		A	A	A	A
12102	Magnesium	AA-Direct	OF	Q	Q	Q	Q
80011	Mercury-tot	Flameless-AA		A	A	A	A
42005	Molybdenum	AA-Solvent extract (MIBK)		A	A	A	A
07015	N-TKN	Automated Colourimetric	OF	Q	Q	Q	Q
10401	NFR	Gravimetric	OF	Q	Q	Q	Q
10501	NFR (F)	Gravimetric	OF	Q	Q	Q	Q
28002	Nickel-tot	AA-Solvent extract (MIBK)	OF	Q	Q	Q	Q
07110	Nitrate + NO_2	Automated Colourimetric	OF	Q	Q	Q	Q
06521	Oil and Grease	Pet. Ether Extraction		A	A	A	A
08102	Oxygen-diss	Meter	OF	Q	Q	Q	Q
15406	Phosphorus-tot	Colourimetry	OF	Q	Q	Q	Q
19103	Potassium	Flame Photometry	OF	Q	Q	Q	Q
34005	Selenium-Ext	Hydride Generation		A	A	A	A
11103	Sodium	Flame Photometry	OF	Q	Q	Q	Q
16306	Sulphate	Colourimetry	OF	Q	Q	Q	Q
10451	TDS	Gravimetric	OF	Q	Q	Q	Q
02061	Temperature	Thermometer	OF	Q	Q	Q	Q
23004	Vanadium-tot	AA-Direct		A	A	A	A
30005	Zinc-tot	AA-Solvent extract (MIBK)		A	A	A	A
10301	pH	Electrometric	W	Q	Q	Q	Q

* Computer storage and retrieval system - Saskatchewan Environment and Resource Managment.

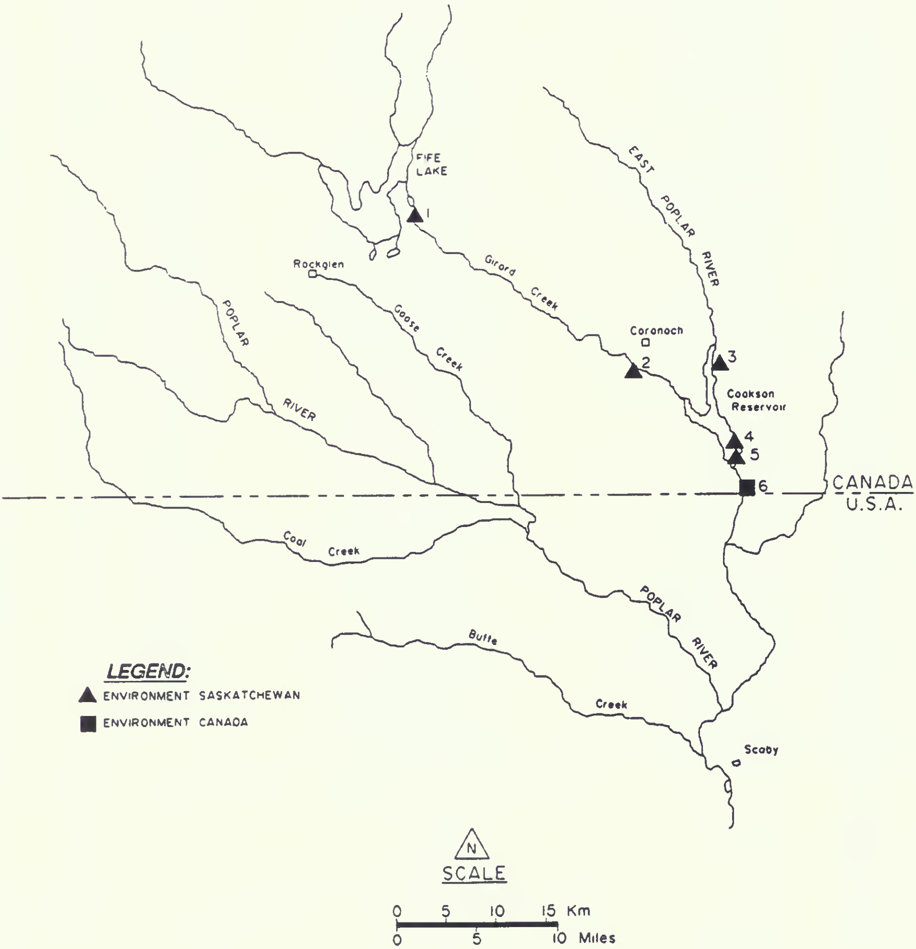
Symbols:

W - Weekly during overflow; **OF**- Once during each period of overflow greater than 2 weeks' duration;
Q - Quarterly; **A** - Annually in the fall; **AA** - Atomic absorption;
Pot - Potentiometric; **NFR**- Nonfilterable residue; **NFR(F)** - Nonfilterable residue, fixed;
ICAP - Inductively Coupled Argon Plasma;
AA - Solvent Extract (MIBK) - Sample digested with HNO_3 and extracted with methyl isobutyl ketone;

PARAMETERS (Continued)

Responsible Agency: Environment Canada			
NAQUADAT* Code	Parameter	Analytical Method	Sampling Frequency Station No. 6
10151	Alkalinity-phenolphthalein	Potentiometric Titration	BM
10111	Alkalinity-total	Potentiometric Titration	BM
13009	Aluminum	ICAP	BM
07570	Ammonia-free	Calculated	BM
07540	Ammonia-total	Automated Colourimetric	BM
56009	Barium-total	ICAP	BM
06201	Bicarbonates	Calculated	BM
05211	Boron	ICAP	BM
48009	Cadmium-total	ICAP	BM
20103	Calcium	ICAP	BM
06104	Carbon-dissolved organic	Automated IR Detection	BM
06901	Carbon-particulate	Elemental Analyzer	BM
06002	Carbon-total organic	Calculated	BM
06301	Carbonates	Calculated	BM
17206	Chloride	Automated Colourimetric	BM
24009	Chromium-total	ICAP	BM
27009	Cobalt-total	ICAP	BM
02021	Colour	Comparator	BM
02041	Conductivity	Wheatstone Bridge	BM
29009	Copper-total	ICAP	BM
09117	Fluoride-dissolved	Electrometric	BM
06401	Free Carbon Dioxide	Calculated	BM
10602	Hardness	Calculated	BM
08501	Hydroxide	Calculated	BM
26009	Iron	ICAP	BM
82009	Lead-Total	ICAP	BM
12102	Magnesium	AA-Direct	BM
25010	Manganese	ICAP	BM
80011	Mercury-total	Flameless AA	BM
07901	N-Particulate	Elemental Analyzer	BM
07651	N-total dissolved	Automated UV Colourimetric	BM
10401	NFR	Gravimetric	BM
28009	Nickel-total	ICAP	BM
07110	Nitrate/Nitrite	Colourimetric	BM
07603	Nitrogen-total	Calculated	BM
10650	Non-Carbonate Hardness	Calculated	BM
08101	Oxygen-dissolved	Winkler	BM
15901	P-particulate	Calculated	BM
15465	P-total dissolved	Colourimetric (TRAACS)	BM
15423	Phosphorus-total	Colourimetric (TRAACS)	BM
19103	Potassium	Flame Emission	BM
11250	Percent Sodium	Calculated	BM
00210	Saturation Index	Calculated	BM
14108	Silica	Automated Colourimetric	BM
11103	Sodium	Flame Emission	BM
00211	Stability Index	Calculated	BM
16306	Sulphate	Automated Colourimetric	BM
00201	TDS	Calculated	BM
02061	Temperature	Digital Thermometer	BM
02073	Turbidity	Nephelometry	BM
23009	Vanadium-total	ICAP	BM
30009	Zinc-total	ICAP	BM

* - Computer Storage and Retrieval System -- Environment Canada
AA - Atomic Absorption **IR** - Infrared **UV** - Ultraviolet
NFR - Nonfilterable Residue **MC** - Monthly Composite **BM** - Bimonthly (Alternate months sampled by USGS)
ICAP - Inductively Coupled Argon Plasma



SURFACE WATER QUALITY MONITORING STATIONS (CANADA)

GROUND-WATER QUALITY MONITORING
SAMPLING LOCATIONS

Responsible Agency: Saskatchewan Environment and Resource Management			
		STATION DESCRIPTION	
Map Location No.	SPC Piezometer No.	Tip of Screen Elevation (m)	Material
8a	C726A**	746.338	unoxidized till
8a	C762C**	752.739	oxidized till
8a	C726E**	738.725	Empress gravel
9a	C728A**	753.405	oxidized till
9a	C728B**	743.265	unoxidized till
9a	C728C**	747.645	mottled till
9a	C728D**	752.305	oxidized till
9a	C728E**	739.912	Empress gravel
2a	C712B	746.112	intra till sands
2b	C718**	748.385	mottled till
2c	C719**	747.715	oxidized till
22	C533**	740.441	Empress gravel
23	C534**	753.449	oxidized till
18	C741**	735.153	Empress gravel
21	C742**	741.800	Empress gravel
24	C724A**	745.333	unoxidized till
25	C714D**	750.459	oxidized till
26	C714E**	738.230	Empress gravel
27	C774B**	749.370	oxidized till
28	C775A**	753.320	oxidized till
29	C775D**	740.190	Empress gravel
2a	C712A	--	unoxidized till
2a	C712C	--	mottled till
2a	C712D	--	oxidized till
2a	C766	--	intra till sands
2a	C767	--	intra till sands
7a	C729A**	--	unoxidized till
7a	C729B**	--	mottled till
7a	C729D**	--	oxidized till
7a	C729E**	--	Empress gravel
6a	C763A**	--	mottled till
6a	C763B**	--	oxidized till
6a	C763D**	--	unoxidized till
6a	C763E**	--	Empress gravel
10	C749**	--	mottled till
7	C655A**	--	unoxidized till
3	C713**	--	oxidized till
4	C714C**	--	oxidized till
5	C715**	--	oxidized till
1	C716**	--	oxidized till
13	C745**	--	oxidized till
21	C753**	--	oxidized till
28	C755B**	--	oxidized till
4	C776A**	--	oxidized till
4	C776B**	--	oxidized till
5	C758**	--	intra till sands
C653A	C653A**	--	unoxidized till
4	C757**	--	unoxidized till
27	C774C**	--	unoxidized till
28	C775C**	--	unoxidized till
24	C750**	--	unoxidized till
23	C751**	--	unoxidized till
22	C752**	--	unoxidized till
1	C731**	--	Empress gravel
C739	C739**	--	Empress gravel
27	C774D**	--	Empress gravel
28	C775D**	--	Empress gravel
23	C732**	--	Empress gravel
22	C733**	--	Empress gravel
24	C734**	--	Empress gravel
C531	C531**	--	oxidized till
C529	C529**	--	Empress gravel
C530	C530**	--	Empress gravel
C532	C532**	--	Empress gravel
C538	C538**	--	Empress gravel

** Analyze annually for all Parameters (except conductivity and water level) -- Information not available

PARAMETERS

Responsible Agency: Saskatchewan Environment and Resource Management			
ESQUADAT* Code	Parameter	Analytical method	Sampling Frequency Station No.: Piezometers
10101	Alkalinity-tot	Pot-Titration	A
13105	Aluminum-Diss	AA-Direct	3**
33104	Arsenic-Diss	Flameless AA	A
56104	Barium-Diss	AA-Direct	A
06201	Bicarbonates	Calculated	A
06106	Boron-Diss	Colourimetry	3**
48102	Cadmium-Diss	AA-Solvent Extract (MIBK)	A
20103	Calcium-Diss	AA-Direct	A
06301	Carbonates	Calculated	A
17203	Chloride-Diss	Colourimetry	A
24104	Chromium-Diss	AA-Direct	A
27102	Cobalt-Diss	AA-Solvent Extract (MIBK)	A
02011	Colour	Comparator	A
02041	Conductivity	Conductivity Meter	A
29105	Copper-Diss	AA-Solvent Extract (MIBK)	4**
09103	Fluoride-Diss	Specific Ion Electrode	A
26104	Iron-Diss	AA-Direct	A
82103	Lead-Diss	AA-Solvent Extract (MIBK)	A
12102	Magnesium-Diss	AA-Direct	A
25104	Manganese-Diss	AA-Direct	A
80111	Mercury-Diss	Flameless AA	A
42102	Molybdenum-Diss	AA-Solvent Extract (N-Butyl acetate)	A
10301	pH	Electrometric	3**
19103	Potassium-Diss	Flame Photometry	A
34105	Selenium-Diss	Hydride generation	A
14102	Silica-Diss	Colourimetry	A
11103	Sodium-Diss	Flame Photometry	A
38101	Strontium-Diss	AA-Direct	3**
16306	Sulphate-Diss	Colourimetry	3**
10451	TDS	Gravimetric	3**
92111	Uranium-Diss	Fluorometry	3**
23104	Vanadium-Diss	AA-Direct	A
97025	Water Level		4
30105	Zinc-Diss	AA-Solvent Extract (MIBK)	A

No zinc or iron for Piezometers C531 to C538
* Computer storage and retrieval system
-- Saskatchewan Environment and Resource Management
** Analyze annually for these Piezometers Nos.

SYMBOLS: **AA** - Atomic absorption
A - Annually
3 - 3 times/year
AA - Solvent Extract (MIBK) - sample acidified and extracted with Methyl Isobutyl Ketone.
4 - 4 times/year

GROUND-WATER PIEZOMETERS TO MONITOR POTENTIAL DRAWDOWN DUE TO COAL SEAM DEWATERING

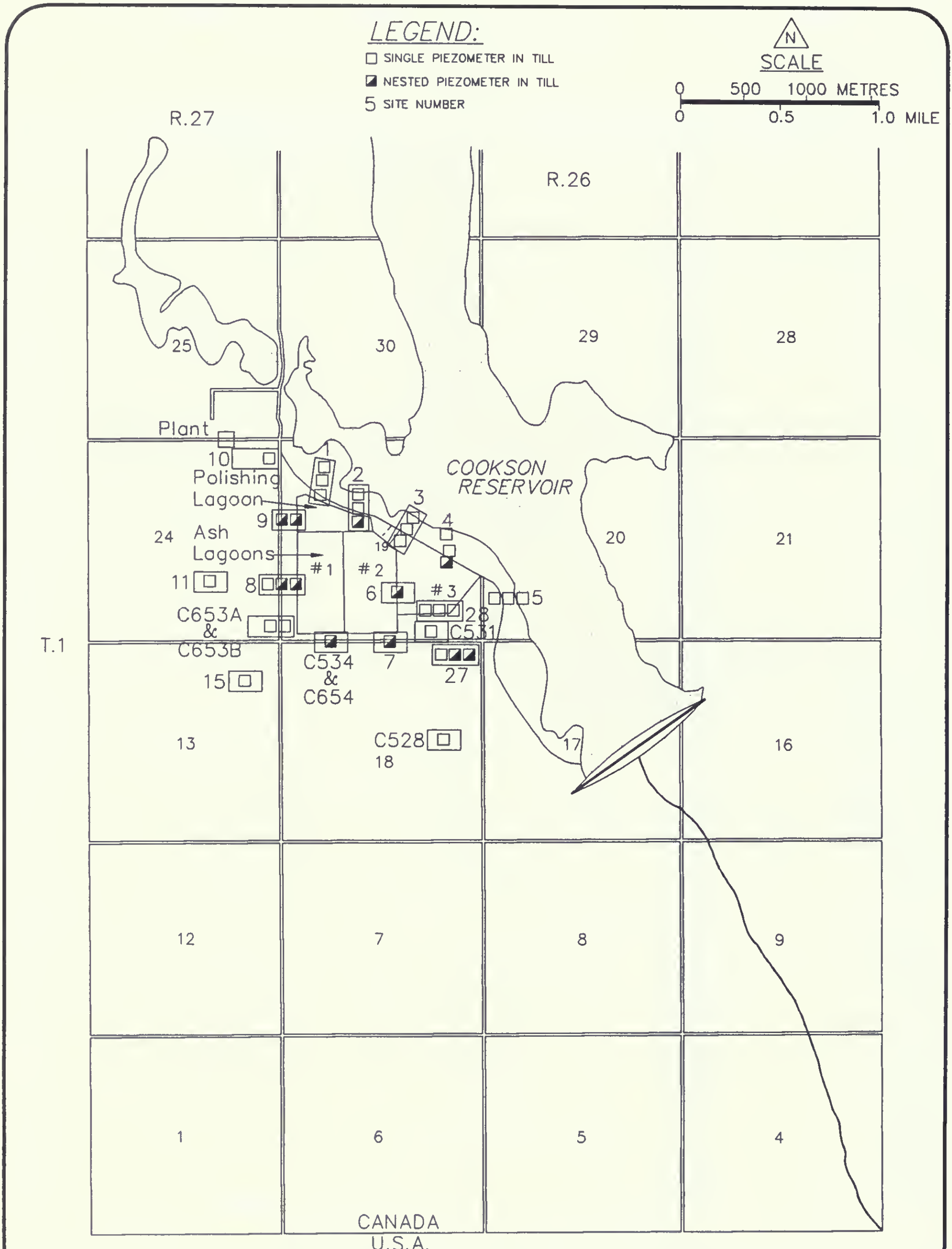
Responsible Agency: Saskatchewan Environment and Resource Management			
Measurement Frequency: Quarterly			
Piezometer Number	**Location**	**Tip of Screen Elevation (m)**	**Perforation Zone (depth in metres)**
52	NW 14-1-27 W3	738.43	43 - 49 (in coal)
506	SW 4-1-27 W3	748.27	81 - 82 (in coal)
507	SW 6-1-26 W3	725.27	34 - 35 (in coal)
509	NW 11-1-27 W3	725.82	76 - 77 (in coal)
510	NW 1-1-28 W3	769.34	28 - 29 (in layered coal and clay)

GROUNDWATER PIEZOMETERS TO MONITOR POTENTIAL DRAWDOWN DUE TO COAL SEAM DEWATERING

GROUND-WATER PIEZOMETER LEVEL MONITORING -- ASH LAGOON AREA

Schedule A -- Piezometers in Till

Responsible Agency: Saskatchewan Environment and Resource Management		
STATION	**PIEZOMETER NO.**	**FREQUENCY OF MEASUREMENT**
1a	C716	All piezometer levels are measured quarterly.
1b	C717	
1c	C711	
1	C765	
$2a_1$	C712A	
$2a_2$	C712B	
$2a_3$	C712C	
$2a_4$	C712D	
2b	C718	
2c	C719	
3a	C713	
3b	C720	
3c	C721	
4	C741B	
4	C722	
4	C723	
5	C724	
5	C725	
$6a_1$	C763A	
$6a_2$	C763B	
$6a_3$	C763C	
$6a_4$	C763D	
6b	C765B	
6b	C765C	
6b	C765D	
6b	C765E	
6c	C767B	
$7a_1$	C729A	
$7a_2$	C729B	
$7a_3$	C729C	
$7a_4$	C729D	
7	C655B	
C534	C534	
C528	C528	
C654	C654	
$8a_1$	C730A	
$8b_1$	C727A	
$8b_2$	C727B	
$8b_3$	C727C	
$8c_1$	C726A	
$8c_2$	C726B	
$8c_3$	C726C	
8d	C748	
$9a_1$	C764A	
$9a_2$	C764B	
$9a_3$	C764C	
$9a_4$	C764D	
$9b_1$	C728A	
$9b_2$	C728B	
$9b_3$	C728C	
$9b_4$	C728D	
11	C747	
15	C746	
28	C768C	
28	C768D	
28	C768E	

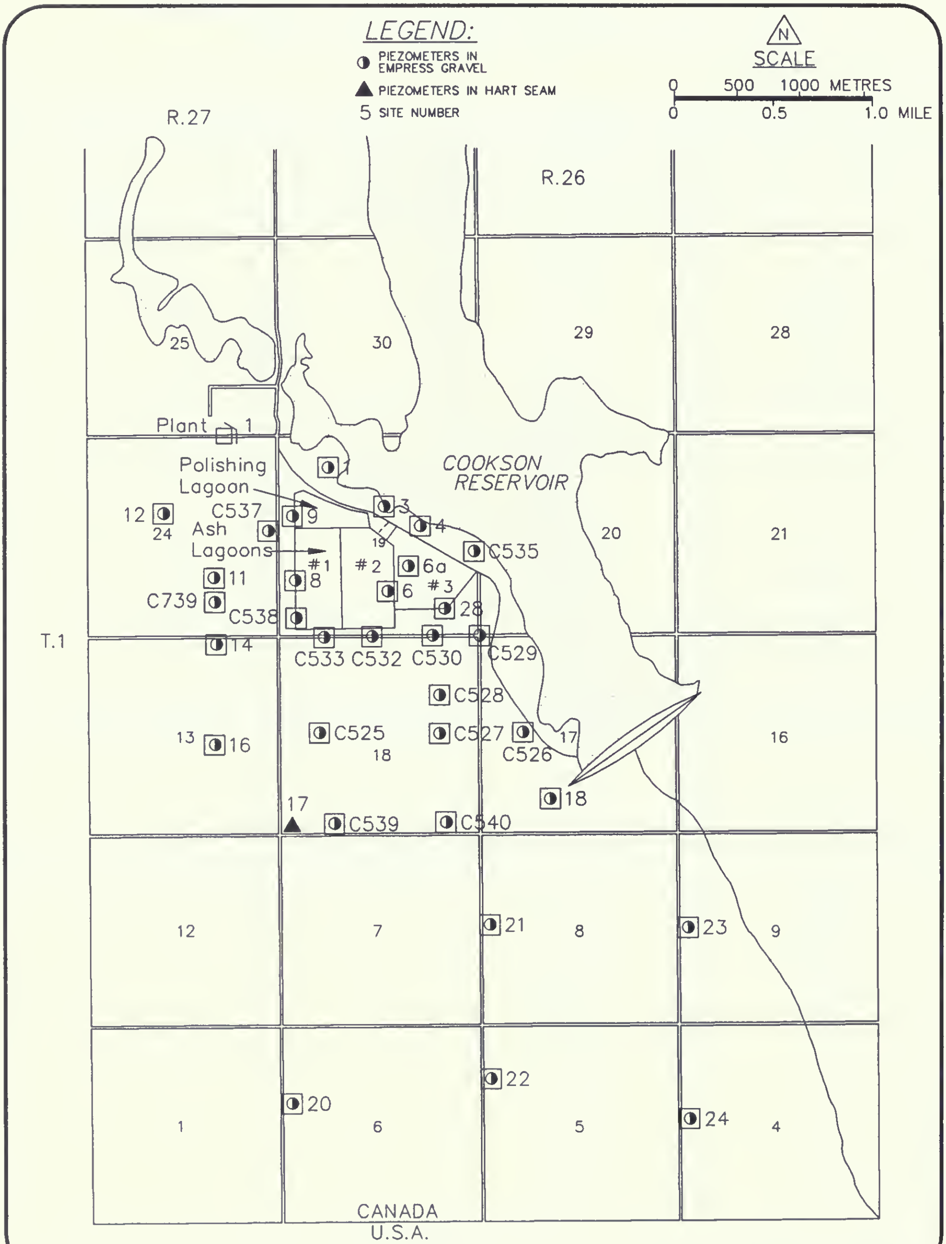


PIEZOMETER INSTALLATION SITES–SCHEDULE "A" PIEZOMETERS IN TILL

GROUND-WATER PIEZOMETER LEVEL MONITORING
-- ASH LAGOON AREA AND INTERNATIONAL BOUNDARY AREA
Schedule B - Piezometers in Empress Gravel

Responsible Agency: Saskatchewan Environment and Resource Management		
STATION	PIEZOMETER NO.	FREQUENCY OF MEASUREMENT
IMMEDIATE ASH LAGOON AREA		
1	C731	All piezometers are monitored quarterly
6a	C763E	
6b	C765A	
C529	C529	
C530	C530	
C532	C532	
C533	C533	
C538	C538	
8	C730E	
9	C728E	
9	C764E	
4	C766A	
6	C767A	
28	C768A	
C535	C535	
1	C536	
C537	C537	
3	C542	
WEST OF ASH LAGOON AREA		
C739	C739	All piezometers are monitored quarterly
11	C743	
14	C740	
12	C737	
SOUTH OF ASH LAGOON AREA		
C525	C525	All piezometers are monitored quarterly
C526	C526	
C527	C527	
C528	C528	
C539	C539	
C540	C540	
18	C741	
20*	C736	
21	C742	
22	C733	
23	C732	
24	C734	
16	C756	

* Inactive as of 1989



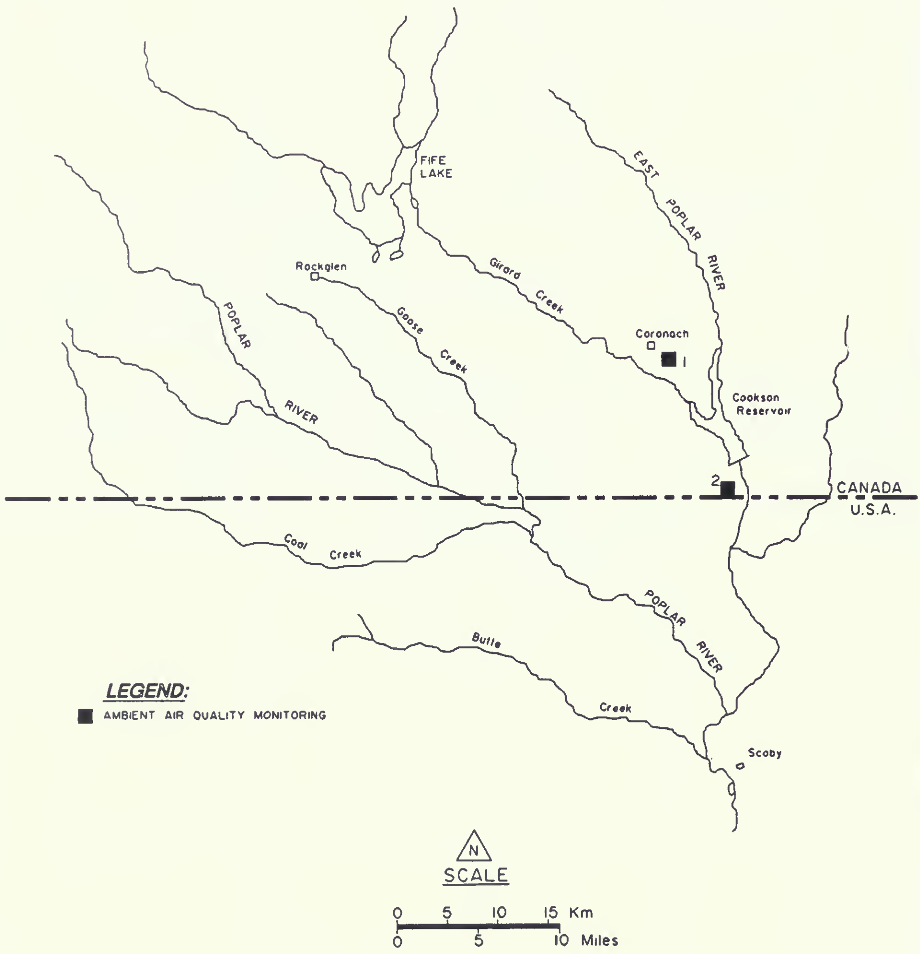
PIEZOMETER INSTALLATION SITES-SCHEDULE "B" PIEZOMETERS IN EMPRESS GRAVEL

AMBIENT AIR QUALITY MONITORING

Responsible Agency: Saskatchewan Environment and Resource Management			
NO. ON MAP	**LOCATION**	**PARAMETERS**	**REPORTING FREQUENCY**
1	Coronach (Discontinued)	Sulphur Dioxide	Discontinued
		Wind speed and direction	Discontinued
		Total Suspended Particulate	Discontinued
2	International Boundary*	Sulphur Dioxide	Continuous monitoring with hourly averages as summary statistics.
		Total Suspended Particulate	24-hour samples on 6-day cycle, corresponding to the National Air Pollution Surveillance Sampling Schedule.

METHODS	
Sulphur Dioxide	Saskatchewan Environment and Resource Management Colourimetric Titration, Pulsed Fluorescence
Total Suspended Particulate	Saskatchewan Environment and Resource Management High Volume Method

* This station operated by SaskPower.



AMBIENT AIR QUALITY MONITORING (CANADA)

POPLAR RIVER

COOPERATIVE MONITORING ARRANGEMENT

TECHNICAL MONITORING SCHEDULES

1993

UNITED STATES

STREAMFLOW MONITORING

Responsible Agency: U.S. Geological Survey		
No. on Map	**Station Number**	**Station Name**
1*	06178000 (11AE008)	Poplar River at International Boundary
2*	06178500 (11AE003)	East Poplar River at International Boundary

*International Gauging Station

HYDROMETRIC GAUGING STATIONS (UNITED STATES)

SURFACE-WATER QUALITY MONITORING

Responsible Agency: U.S. Geological Survey		
No. on Map	USGS Station No.	Station Name
1	06178000	Poplar River at International Boundary
2	06178500	East Poplar River at International Boundary
3	06179000	East Poplar River near Scobey

PARAMETERS					
WATSTORE*			SAMPLING FREQUENCY		
Code	Parameter	Analytical Method	1	2	3
90410	Alkalinity - lab	Elect. Titration	M	BM	BM
01106	Aluminum - diss	AE,DC Plasma	SA	SA	SA
00610	Ammonia -tot	Colorimetric	M	BM	BM
00625	Ammonia +Org N-tot	Colorimetric	M	BM	BM
01000	Arsenic - diss	AA, hydride	SA	SA	SA
01002	Arsenic - tot	AA, hydride	A	A	A
01010	Beryllium - diss	ICP	SA	SA	SA
01012	Beryllium - tot/rec	AA - Persulfate	A	A	A
01020	Boron - diss	AE, DC Plasma	M	BM	BM
01025	Cadmium - diss	AA, GF	SA	SA	SA
01027	Cadmium - tot/rec	AA, GF - Persulfate	A	A	A
00915	Calcium	ICP	M	BM	BM
00680	Carbon - tot Org	Wet Oxidation	SA	SA	SA
00940	Chloride - diss	Colorimetric	M	BM	BM
01030	Chromium - diss	AE,DC Plasma	SA	SA	SA
01034	Chromium - tot/rec	AE, DC Plasma - Persulfate	A	A	A
00080	Colour	Electrometric, visual	M	BM	BM
00095	Conductivity	Wheatstone Bridge	M	D	BM
01040	Copper - diss	AA, GF	SA	SA	SA
01042	Copper - tot/rec	AA, GF - Persulfate	A	A	A
00061	Discharge -Inst	Direct measurement	M	BM	BM
00950	Fluoride	Electrometric	M	BM	BM
01046	Iron - diss	AE, ICP	M	BM	BM
01045	Iron - tot/rec	AA-Persulfate	A	A	A
01049	Lead -diss	AA, GF	SA	SA	SA
01051	Lead - tot/rec	AA, GF -Persulfate	A	A	A
00925	Magnesium - diss	AA	M	BM	BM
01056	Manganese - diss	ICP	SA	SA	SA
01055	Manganese - tot/rec	AA-Persulfate	A	A	A
01065	Nickel - diss	AA, GF	SA	SA	SA
01067	Nickel - tot/rec	AA, GF - Persulfate	A	A	A
00615	Nitrite - tot	Colorimetric	M	BM	BM
00630	Nitrate + Nitrite - tot	Colorimetric	M	BM	BM
00300	Oxygen - diss	Winkler/meter	M	BM	BM
70507	Phos, Ortho - tot	Colorimetric	M	BM	BM
00400	pH	Electrometric	M	BM	BM
00665	Phosphorus - tot	Colorimetric	M	BM	BM
00935	Potassium - diss	AA	M	BM	BM
00931	SAR	Calculated	M	BM	BM
80154	Sediment - conc.	Filtration-Gravimetric	M	BM	BM
80155	Sediment - load	Calculated	M	BM	BM
01145	Selenium - diss	AA, hydride	SA	SA	SA
01147	Selenium - tot	AA, hydride	A	A	A
00955	Silica	ICP	M	BM	BM
00930	Sodium	ICP	M	BM	BM
00945	Sulphate - diss	Turbimetry	M	BM	BM
70301	Total Dissolved Solids	Calculated	M	BM	BM
00010	Temp Water	Stem Thermometer	M	BM	BM
00020	Temp Air	Stem Thermometer	M	BM	BM
00076	Turbidity	Nephelometric	M	BM	BM
80020	Uranium - diss	Spectrometry	-	MC	-
01090	Zinc - diss	ICP	SA	SA	SA
01092	Zinc - tot/rec	AA-Persulfate	A	A	A

SYMBOLS: D - daily; **M** - monthly; **BM** - bimonthly; **MC** - monthly composite; **A** - annually at high flow; **SA** - semi-annually at low and high flow; **GF**, graphite furnace; **AA** - atomic absorption; tot - total; rec - recoverable; diss - dissolved; **AE** - atomic emission; **DC** - direct current; **ICP**, inductively coupled plasma

* - Computer storage and retrieval system - USGS

SURFACE WATER QUALITY MONITORING STATIONS (UNITED STATES)

GROUND-WATER QUALITY MONITORING
Station Locations

Responsible Agency: Montana Bureau of Mines and Geology

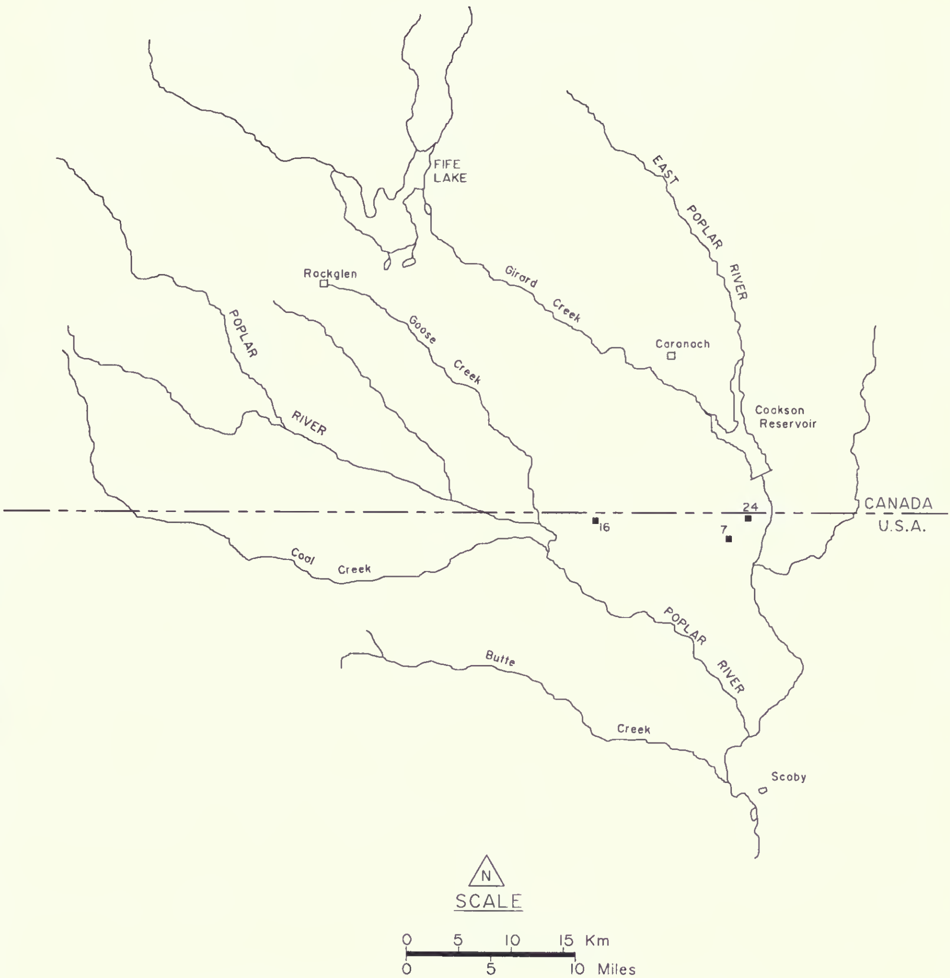
Map Number	Well Location	Total Depth (m)	Casing Diameter (cm)	Aquifer	Perforation Zone (m)
7	37N47E12BBBB	44.1	10.2	Hart Coal	39-44
16	37N46E3ABAB	25.5	10.2	Fort Union	23-25
24	37N48E5AB	9.6	10.2	Alluvium	9.2-9.6

Parameters

Storet ** Code	Parameter	Analytical Method	Sampling Frequency Station No.
00440	Bicarbonates	Electrometric Titration	Sample collection is annually for all locations identified above.
01020	Boron-diss	Emission Plasma, ICP	
00915	Calcium	Emission Plasma	
00445	Carbonates	Electrometric Titration	The analytical method descriptions are those of the Montana Bureau of Mines and Geology Laboratory where the samples are analyzed.
00940	Chloride	Ion Chromatography	
00095	Conductivity	Wheatstone Bridge	
01040	Copper-diss	Emission Plasma, ICP	
00950	Fluoride	Ion Chromatography	
01046	Iron-diss	Emission Plasma, ICP	
01049	Lead-diss	Emission Plasma, ICP	
01130	Lithium-diss	Emission Plasma, ICP	
00925	Magnesium	Emission Plasma, ICP	
01056	Manganese-diss	Emission Plasma, ICP	
01060	Molybdenum	Emission Plasma, ICP	
00630	Nitrate	Ion Chromatography	
00400	pH	Electrometric	
00935	Potassium	Emission Plasma, ICP	
01145	Selenium-diss	AA	
00955	Silica	Emission Plasma, ICP	
00930	Sodium	Emission Plasma, ICP	
01080	Strontium-diss	Emission Plasma, ICP	
00445	Sulphate	Ion Chromatography	
00190	Zinc-diss	Emission Plasma, ICP	
70301	TDS	Calculated	

SYMBOLS: AA - Atomic Absorption; ICP - Inductively Coupled Plasma Unit

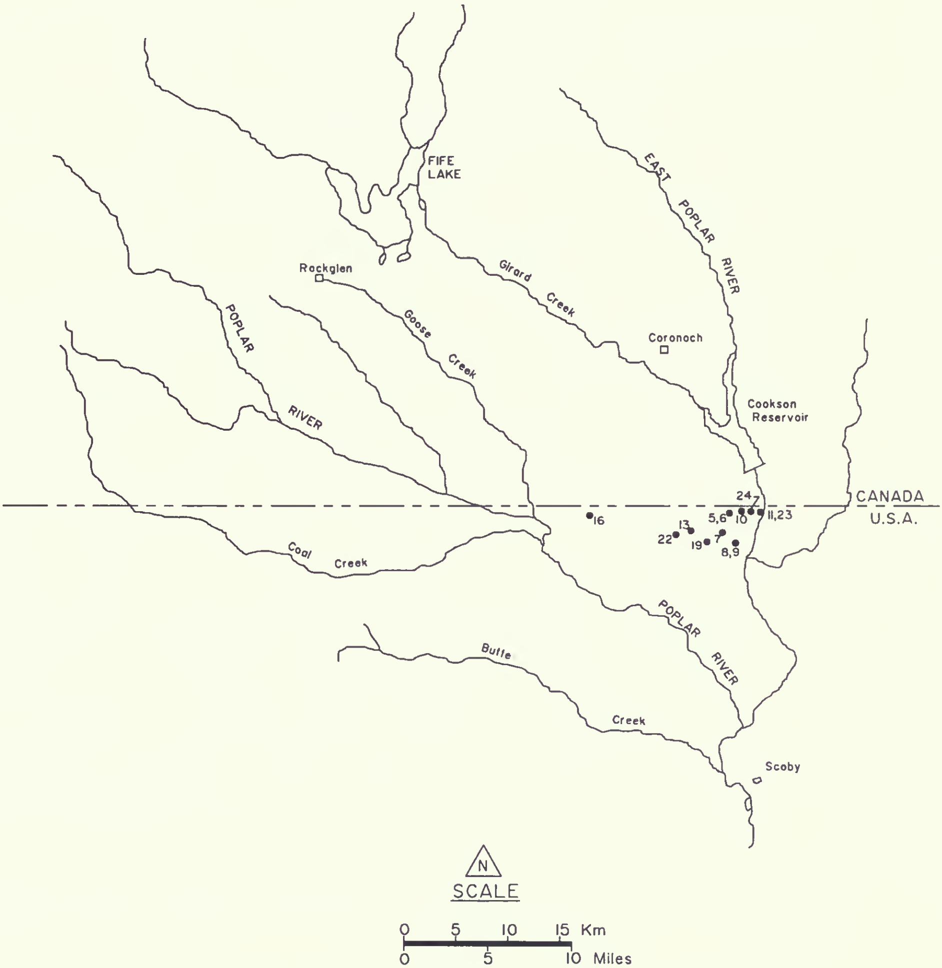
** - Computer storage and retrieval system-- EPA



GROUNDWATER QUALITY MONITORING (UNITED STATES)

GROUND-WATER LEVELS TO MONITOR POTENTIAL DRAWDOWN DUE TO COAL SEAM DEWATERING

Responsible Agency: Montana Bureau of Mines and Geology	
No. on Map	**Sampling**
2 to 24	Determine water levels quarterly



GROUNDWATER PIEZOMETERS TO MONITOR POTENTIAL DRAWDOWN DUE TO COAL SEAM DEWATERING

ANNEX 3

RECOMMENDED FLOW APPORTIONMENT

IN THE POPLAR RIVER BASIN

BY THE INTERNATIONAL SOURIS-RED RIVERS ENGINEERING BOARD,

POPLAR RIVER TASK FORCE (1976)

*RECOMMENDED FLOW APPORTIONMENT IN THE POPLAR RIVER BASIN

The aggregate natural flow of all streams and tributaries in the Poplar River Basin crossing the International Boundary shall be divided equally between Canada and the United States subject to the following conditions:

1. The total natural flow of the West Fork Poplar River and all its tributaries crossing the International Boundary shall be divided equally between Canada and the United States but the flow at the International Boundary in each tributary shall not be depleted by more than 60 percent of its natural flow.

2. The total natural flow of all remaining streams and tributaries in the Poplar River Basin crossing the International Boundary shall be divided equally between Canada and the United States. Specific conditions of this division are as follows:

   (a) Canada shall deliver to the United States a minimum of 60 percent of the natural flow of the Middle Fork Poplar River at the International Boundary as determined below the confluence of Goose Creek and Middle Fork.

   (b) The delivery of water from Canada to the United States on the East Poplar River shall be determined on or about the first day of June each year as follows:

      (i) When the total natural flow of the Middle Fork Poplar River, as determined below the confluence of Goose Creek, during the immediately preceding March 1st to May 31st period does not exceed 4,690 cubic decameters (3,800 acre-feet), then a continuous minimum flow of 0.028 cubic metres per second (1.0 cubic feet per second) shall be delivered to the United States on the East Poplar River at the International Boundary throughout the succeeding 12 month period commencing June 1st. In addition, a volume of 370 cubic decameters (300 acre-feet) shall be delivered to the United States upon demand at any time during the 12 month period commencing June 1st.

      (ii) When the total natural flow of the Middle Fork Poplar River, as determined below the confluence of Goose Creek, during the immediately preceding March 1st to May 31st period is greater than 4,690 cubic decameters (3,800 acre-feet), but does not exceed 9,250 cubic decameters (7,500 acre-feet), then a continuous minimum flow of 0.057 cubic metres per second (2.0 cubic feet per second) shall be delivered to the United States on the East Poplar River at the International Boundary during the succeeding period June 1st through August 31st. A minimum delivery of 0.028 cubic metres per second (1.0 cubic feet per second) shall then be maintained from September 1st through to May 31st of the following year. In addition, a volume of 617 cubic decameters (500 acre-feet) shall be delivered to the United States upon demand at any time during the 12-month period commencing June 1st.

      (iii) When the total natural flow of the Middle Fork Poplar River, as determined below the confluence of Goose Creek, during the immediately preceding March 1st to May 31st period is greater than 9,250 cubic decameters (7,500 ace-feet), but does

* Canada-United States, 1976, Joint studies for flow apportionment, Poplar River Basin, Montana-Saskatchewan: Main Report, International Souris-Red Rivers Board, Poplar River Task Force, 43 pp.

not exceed 14,800 cubic decameters (12,000 acre-feet), then a continuous minimum flow of 0.085 cubic metres per second (3.0 cubic feet per second) shall then be delivered to the United States on the East Poplar River at the International Boundary during the succeeding period June 1st through August 31st. A minimum delivery of 0.057 cubic metres per second (2.0 cubic feet per second) shall then be maintained from September 1st through to May 31st of the following year. In addition, a volume of 617 cubic decameters (500 acre-feet) shall be delivered to the United States upon demand at any time during the 12-month period commencing June 1st.

(iv) When the total natural flow of the Middle Fork Poplar, as determined below the confluence of Goose Creek, during the immediately preceding March 1st to May 31st period exceeds 14,800 cubic decameters (12,000 acre-feet) then a continuous minimum flow of 0.085 cubic metres per second (3.0 cubic feet per second) shall be delivered to the United States on the East Poplar River at the International Boundary during the succeeding period June 1st through to August 31st. A minimum delivery of 0.057 cubic metres per second (2.0 cubic feet per second) shall then be maintained from September 1st through to May 31st of the following year. In addition, a volume of 1,230 cubic decameters (1,000 acre-feet) shall be delivered to the United States upon demand at any time during the 12-month period commencing June 1st.

(c) The natural flow at the International Boundary in each of the remaining individual tributaries shall not be depleted by more than 60 percent of its natural flow.

3. The natural flow and division periods for apportionment purposes shall be determined, unless otherwise specified, for periods of time commensurate with the uses and requirements of both countries.

ANNEX 4

METRIC CONVERSIONS

METRIC CONVERSION FACTORS

ac	=	4,047 m^3 = 0.04047 ha
ac-ft	=	1,233.5 m^3 = 1.2335 dam^3
C^o	=	$5/9(F^o - 32)$
cm	=	0.3937 in.
cm^2	=	0.155 in^2
dam^3	=	1,000 m^3 = 0.8107 ac-ft
ft^3	=	28.3171 x $10^{-3} m^3$.
ha	=	10,000 m^2 = 2.471 ac
hm	=	100 m = 328.08 ft
hm^3	=	1 x 10^6 m^3
I.gpm	=	0.0758 L/s
in	=	2.54 cm
kg	=	2.20462 lb = 1.1 x 10^{-3} tons
km	=	0.62137 miles
km^2	=	0.3861 mi^2
L	=	0.3532 ft^3 = 0.21997 I.gal = 0.26420 U.S. gal
L/s	=	0.035 cfs = 13.193 I.gpm = 15.848 U.S. gpm
m	=	3.2808 ft
m^2	=	10.7636 ft^2
m^3	=	1,000 L = 35.3144 ft^3 = 219.97 I.gal = 264.2 U.S. gal
m^3/s	=	35.314 cfs
mm	=	0.00328 ft
tonne	=	1,000 kg = 1.1023 ton (short)
U.S. gpm	=	0.0631 L/s

<u>For Air Samples</u>

ppm = 100 pphm = 1000 x (Molecular Weight of substance/24.45) mg/m^3

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